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# A Course of Study for General Chemistry

Paul E. Kerrick

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A COURSE OF STUDY FOR GENERAL CHEMISTRY

BY

PAUL E. KERRICK

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF ARTS

WESTERN KENTUCKY STATE COLLEGE

JULY, 1951



Approved:-

Major Professor

Department of Education

Graduate Committee

*Burt R. Smith*  
*For Francis Jones*  
*B. R. Smith*

#### ACKNOWLEDGMENT

The writer wishes to express a sincere appreciation for the guidance and constructive criticism given him by Doctor Bert R. Smith, and Doctor Lee Francis Jones.

P. E. K.

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## CHAPTER I

### AN INTRODUCTION TO THE STUDY

The writer, after having majored in chemistry and having taught it for three years, is attempting to organize his past experiences, knowledge, and materials into a concise form. It is hoped that by doing this it will be possible to make the course in general chemistry more interesting and beneficial to his students and help the teacher do better teaching.

The writer realizes that he has three types of students in his classes: First, those who plan to continue their education by attending college and entering the fields of medicine, engineering, pharmacy, dentistry, farming, etc., and have a need for a basic knowledge of chemistry; second, those who do not plan to continue their education beyond the high school level but feel that they have an interest in science and can use a basic knowledge of chemistry in their everyday vocation and avocation; third, those students who feel that they have no interest in the course of chemistry but have no other course available and need four units to complete the requirements for high school graduation.

The writer hopes that by organizing his materials and seeking new materials he can make the chemistry curriculum better fit the needs and interests of the students and him. It is hoped that there will be a greater interest in the high school course of chemistry.

The materials and suggestions in this study could be of interest to anyone who is concerned with the teaching of chemistry and improving the high school course of chemistry.

The following are discussed in the order of their appearance:

1. What prompted the study

2. Statement of the problem
3. Scope of the study
4. Source of the data
5. Technique of treatment
6. Similar studies
7. Chapter summary

What prompted the study.- The writer has felt the need of organizing his materials, knowledge, and experiences into a concise form ever since he entered the teaching field but has neglected to do so because of the great amount of work involved and the lack of sufficient time. However, in taking a course in Secondary School Curriculum while in graduate school and under the direction of Dr. Bert R. Smith, the writer was convinced that the time and work spent in producing a Course of Study in Chemistry was well worth while and would actually result in a saving of time and work in the future.

The writer has two other reasons for developing the course of study in chemistry. One reason is to prepare a thesis in partial fulfillment for the Masters degree. The second reason is that through the development of the course of study the writer may improve his high school course of chemistry by having the materials in an organized form.

Statement of the problem. - This study involves the following divisions:

1. To build a course of study in chemistry consisting of nine units developed.
2. To suggest some ways of evaluating the course of study.

Scope of the study.- The material included in this study will cover an introduction to high school chemistry and the general course of chemistry taught in high school. The student should be able to enter college chemistry

if he so desires and progress at a faster rate than those who have not had high school chemistry. General chemistry is usually taught in the eleventh and twelfth grades.

Source of the data.- The material for the study has been taken from the following:

1. Text books on general chemistry.
2. Laboratory manuals on general chemistry.
3. Educational bulletins.
4. Classes in Secondary School Curriculum.
5. Textbooks on the Course of Study and the curriculum building.
6. Courses of study on chemistry.
7. Periodicals.

Technique of treatment.- The writer will attempt to organize the available material in such a way as to make it useful to him and anyone else who is interested in teaching chemistry. The writer realizes that a good course of study should include suggestions made by the students and be tried out. This is not possible at this time since he is engaged in teaching physics. It is hoped that the course of study will be improved next year when it will be given a "try out" and have student participation. A course of study should be constantly changed and improvements made and the writer feels that this can be done if this course of study is used as a basis.

Similar studies.- There has been a number of courses of study prepared in chemistry, but none of these fit the needs of this writer. They have either been prepared in a very condensed form or prepared for an entirely different situation. The writer feels that a course of study should be prepared by the user, for the user, in his own particular situation.

There are three other studies in which the writers have approached their

courses in a similar manner.<sup>1</sup> To the knowledge of this writer there has been no course of study in chemistry which approached the subject in a similar manner.

The present chapter serves as an index to the following chapters:

Chapter II. An Introduction to the Course of Study.

Chapter III. Development of the Course of Study into Units.

Chapter IV. Evaluation.

Chapter V. Summary.

Chapter VI. Bibliography.

Chapter summary.- The following main points are brought out in this chapter:

1. This study should help the teacher create a greater interest among the students for chemistry. The study should enable the teacher to do better teaching.
2. The study was prompted by a felt need on the part of the writer and to satisfy the partial requirement for a Masters degree.
3. The study involves three main divisions:
  - a. A course of study in chemistry consisting of an introduction.
  - b. A course of study in chemistry consisting of nine developed units.

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<sup>1</sup> Hulse, Jane, A Course of Study in Advanced Typewriting, unpublished Master of Arts thesis, Western Kentucky State College, Bowling Green, Kentucky, 1944.

McFarlane, Kathryn, A Course of Study in Beginning Shorthand, unpublished Master of Arts thesis, Western Kentucky State College, Bowling Green, Kentucky, 1944.

Sherfey, Robert, A Course of Study in Plane Geometry, unpublished Master of Arts thesis, Western Kentucky State College, Bowling Green, Kentucky, 1948.

c. The means of evaluating a course of study.

4. The scope of the study includes an introduction to chemistry usually taught in high school.
5. Materials used were taken from as many available sources as possible.
6. There have been no other studies in chemistry that have approached the problem in this manner.



## CHAPTER II

### AN INTRODUCTION TO THE COURSE OF STUDY

Ever since man made his appearance on the earth, he has been seeking the explanation for why things happen as they do. At first his efforts were very limited and at times hindered and often the explanations were simple and ineffective. The great men of early times, which will include some of the greatest scholars of the time such as Socrates, Plato, Aristotle, often missed the correct answer for certain phenomena. They did show the inquisitiveness of man and contributed the great power of man to think and reason. The alchemist, who followed, encouraged the development of science by contributing the necessary step of experimentation. Such people as Vesalius helped science progress by introducing the process of observation.

Only through the use of serious thinking, reasoning, observation, and experimentation can a true conclusion or explanation be reached. It is through this type of procedure that the great field of chemistry has been developed into the place it now holds in every individual's life.

It would be difficult indeed to find some one whose life is not affected by chemistry. The housewife who bakes light rolls or bread, the man who drives a car, the boy or girl who washes his or her face and hands with soap uses chemistry everyday and needs to understand it. Every person in his daily living uses chemistry in using the oxygen he breathes and digestion of the food he eats. These life processes would take place in spite of the fact that the person has no knowledge of chemistry as a subject. However, the individual could and would lead a happier, healthier, and more useful life if he understood the chemical changes taking place in and outside his body during every day living.

The student who takes a course in chemistry should develop within himself the scientific method of approaching the problems of everyday living. While in studying chemistry itself, he will use the scientific method as it applies to problems in chemistry. There should be a certain amount of carry over into other fields.

The student of chemistry should develop a greater appreciation for the field of chemistry and the contributions it has made to his everyday living. It would be difficult to imagine a world without its plastic, steel, oil, gasoline, plywood, etc. All of these are contributions made by the science of chemistry to the world. It is hoped that the writer can create a greater interest in chemistry through better teaching by developing and using this course of study in chemistry.

When the writer first entered the teaching profession he would have welcomed some type of outline or syllabus on what he was expected to teach. Instead of this he received four textbooks, which he had never seen before and then was told what classes he would teach. Perhaps if each of the State Departments of Education in the various states would develop a general course of study for each subject taught or instigate the development of courses of studies by each school district, the instruction in each school would become more uniform and in a more organized manner. Every new teacher would appreciate a course of study in his subjects.

In bringing about a state wide development of courses of study, certain fundamental factors must be taken into consideration. They will be discussed in the following order:

1. Organisation Chart
2. Steps in Curriculum Organisation
3. Philosophy of Education

4. Principles
5. Terminology:
  - a. Course of Study
  - b. Chemistry
6. Objectives of Education
7. Objectives of Subject
8. Structural Pattern for a Unit

Organization chart.— Before any work can be done on a state wide development of courses of study a certain amount of organization work must be done. A chart is available showing the committees needed with their purposes and functions.<sup>2</sup> Each committee should have its purposes, responsible agents, advisory agents, and sub-committees.

1. Steering Committee
2. Administrative Committee
3. Production Committee
4. Installation Committee
5. Evaluation Committee
6. Editing Committee

Steps in curriculum organization.— Once the superintendent senses the need for a curriculum revision program and initiates it, certain steps must be taken to insure an effective and efficient plan of work. The school board must be educated as to the need; a curriculum director appointed; specialist selected; scope, size, length and cost determined; personnel organized into committees. It will be necessary to educate the public and

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<sup>2</sup>

Dr. Bert R. Smith, Professor of Education, Western State College, Bowling Green, Kentucky, 1948.

educational staff, survey the needs of the state, determine objectives of departments and content of material. The work should result in the production of courses of study, their installation and evaluation along with a continuous publicity and revision program.

Philosophy of education .- Before any curriculum revision can be effectively done, one must determine his philosophy of education. If the curriculum revision is to be done on a secondary level, then the philosophy of education should apply to that level and must be based upon certain fundamental principles. A good philosophy of education should embrace the needs of the individual child based upon his abilities and insure him equal opportunities and a place to meet these. The philosophy of education should include the needs of the community and some of the old as well as the new. The student should be encouraged to develop a general education, wholesome attitudes, habits of broad and continuous reading and study, learn to think and acceptance of reasonable authority. Every school should be fitted to the needs of the community and used for the community as long as it benefits from this use. Each organization attempting a curriculum revision must devise its own philosophy of education.

Principles to guide the program.- Before a revision of the curriculum can be effectively accomplished, certain principles must be considered as a basis for curriculum construction. The first principle to be determined is the central philosophy of life, education, and curriculum. Other principles will have to be determined in order to have a continuous program.

#### Terminology

A. Course of study. - In order that every individual involved in the curriculum revision program will have a clear understanding of the program, certain general terms must be defined and clarified. This will result in

much less confusion and misunderstanding. Some of these terms should be: ability, activity, adaptation, aim, attitude, center of interest, concept, core curriculum, correlation, course of study, criterion, curriculum evaluation, objectives, outcome, philosophy of education, principle, program of studies, study guide, subject matter, test, unit of work, worksheet, etc. Each organization must determine its own list and define them for their own use.

B. Chemistry.-- In every course of study there are certain terms that each person must become familiar with in order to master the subject matter. Some of those terms deemed essential for chemistry are given here: acid, alkali, analysis, anhydride, atom, atomic number, atomic weight, base, cubic centimeter, catalyst, chemistry, compound, dissolve, electron, element, gram, equation, formula, gram-molecular weight, halogen, ion, ionization, liter, matter, molar, molecule, neutral, proton, radical, reaction, reduction, salt, solubility, solution, symbol, theory, valance, weight. Each teacher should determine his own list which will no doubt include many additions to the above.

Objectives of Education.-- No project is ever undertaken unless certain aims or objectives have been set up and then plans laid to reach those objectives. This is equally true of education. Each curriculum making group must make a list of the objectives that seem best for its purpose.

The following list has been given as a suggestive list:

1. Health - mental and physical
2. Self-realization
3. Civic responsibility
4. Vocational and avocational fitness
5. World-mindedness

## 6. Command of fundamental processes

Each one should be organized under knowledge and understanding of, attitudes toward, habits of, appreciation for.

### Objectives of General Chemistry

It is impossible today for the average person to not need some knowledge of the field of chemistry. Everyone should be acquainted with some of the basic principles of chemistry and the importance of chemistry in everyday life. With this in mind the writer has set up the following objectives for general high school chemistry:

#### A. Knowledge and Understanding of:

##### 1. Chemistry and our material world

- a. Chemistry and our basic needs
- b. Matter and energy
- c. Measurements
- d. Laws governing gases

##### 2. A picture of matter

- a. Classification of matter
- b. Changes in matter
- c. Oxygen and hydrogen
- d. Water
- e. Air

##### 3. Structure of matter

- a. Characteristics of molecules
  - (1) Motion of
  - (2) Structure of
- b. Atomic and molecular weights
- c. Atomic structure

- d. Chemical behavior of elements
- e. Transmutation of elements
- f. Chemical equations

#### 4. Solutions

- a. How formed
- b. Colloids
- c. Ionic theory
- d. Acids, bases, and salts
- e. Ions and chemical change

#### 5. Nitrogen

- a. Importance of
- b. Preparation of ammonia
- c. Nitric acid
- d. Explosives

#### 6. Carbon

- a. Characteristics of
- b. Compounds of
- c. Fuels
- d. Organic chemistry
- e. Derivatives of hydrocarbons
- f. Foods
- g. Medicine
- h. Textiles
- i. Rubber and plastics

#### 7. The Periodic Law

- a. Purpose of classification
- b. Characteristics of halogen family

c. Use of certain elements

8. Non-metals

a. Sulfur

b. Oxides and acids of sulfur

c. The silicates

9. Metals

a. Characteristics of

b. Iron

c. Light metals

d. Active metals

e. Use of metals

f. "Heavy" metals

B. Attitudes toward:

1. Common principles of chemistry in everyday life

2. Organized thinking

3. Value of experimentation

4. Self-reliance and initiative

5. Conclusions based on proven facts

6. Non-acceptance of unproven facts

7. Snap decisions as unsound

8. The contributions of chemistry to the world

9. Basic principles of chemistry

C. Habits of:

1. Being orderly

2. Being neat

3. Being exact

4. Observing sharply



5. Using correct laboratory procedures
6. Thinking clearly
7. Organizing of facts
8. Developing proven conclusions and ideas
9. Reading scientific articles in magazines and newspapers
10. Using the "scientific method"

D. Appreciation for:

1. Scientific articles in magazines and newspapers
2. Scientific men and their work
3. The advancements of science
4. The improvements of the work by chemistry
5. The voluntary acceptance of facts established by men of science
6. Chemistry and its usefulness
7. Exactness and thoroughness

### THE STRUCTURAL PATTERN FOR A UNIT<sup>3</sup>

- I. Title
- II. Introduction
- III. Table of Contents
- IV. Criteria
- V. Grade Placement - Time Allotment
- VI. Central Theme
- VII. Objectives:
  - A. Knowledge and Understanding of

---

3

Class Discussion

- B. Attitude toward
- C. Habit of
- D. Appreciation for

#### VIII. Approaches

##### IX. Development or procedures:

- A. Study Guides, Specific References, and How to Study
- B. Subject Matter - Knowledges - Understandings
- C. Activities, Projects, Problems
- D. Correlations
- E. Work Sheets

##### X. Culminating Activity

##### XI. Outcomes:

- A. Knowledge and Understanding of
- B. Attitude toward
- C. Habit of
- D. Appreciation for

##### XII. Leads to Other Units

##### XIII. Evaluation - Measuring Results:

- A. Teacher Evaluation
- B. Pupil Test
  - 1. Knowledge
  - 2. Attitude
  - 3. Habit
  - 4. Appreciation

##### XIV. Bibliography:

- A. Teacher
- B. Pupil

## CHAPTER III

## DEVELOPMENT OF THE COURSE OF STUDY INTO UNITS

In this chapter the material to be used in general chemistry is divided into nine units:

- Unit I Chemistry and Our Material World
- Unit II A Chemical View of Matter
- Unit III The Structure of Matter
- Unit IV Theory of Solutions
- Unit V Nitrogen and Its Compounds
- Unit VI The Wonder Element Carbon
- Unit VII The Periodic Law and Chemical Families
- Unit VIII Some Important Non-Metals
- Unit IX The Metals

Each unit is developed according to the structural pattern that is given on page 14.

## Unit No. I

## Chemistry and Our Material World

The student entering the class in chemistry often does so without much of an idea about what he is going to study. He is entering a new field of study much the same as he would the Empire State Building if he had never been there before. He has had little or no introduction to the subject other than the fact that he has been told that he should take chemistry if he is planning to enter the professions of medicine, dentistry, pharmacy, chemical engineering, or become a chemist. Some of the students have had their own home chemistry sets but they still have only a limited knowledge of what is in store for them.

The author feels that the beginning chemistry student can be greatly influenced as to whether he will like chemistry or not like it during the first few weeks of the class. Many of his false impressions must be corrected and new conceptions added. He should then know what is expected of him and where he is going.

The student often feels that chemistry is difficult to master, requires a lot of mathematics, and is written in a strange language. The first unit in chemistry should acquaint the student with how chemistry is related to his everyday life and some of the characteristics of the material things around him.

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#### Criteria for the Evaluation of a Unit<sup>4</sup>

##### Chemistry and Our Material World

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal associations of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.

<sup>4</sup>Harap, Western Reserve Bulletin No. 17, November 30, 1931.

5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilise materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupil to originate, plan, and direct the activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement—Grade eleven or twelve

Time Allotment—Fifteen days

Central Theme—A New World

### Objectives

#### Chemistry and Our Material World

##### A. Knowledge and Understanding of:

1. Chemistry and our basic needs
2. Chemist's relationship with matter and energy
3. Laboratory measurements of length, weight, volume, pressure, temperature

4. The laws of gases

B. Attitude toward:

1. The contributions of chemistry and our high standard of living
2. The characteristics of matter
3. The need of measurements
4. The exactness of chemical measurements
5. Properties of gases

C. Habit of:

1. Studying correctly
2. Associating chemistry with everyday things
3. Applying the properties of matter to everyday phenomena
4. Measuring exactly
5. Using the metric system of measurement
6. Applying the laws of gases to practical applications

D. Appreciation for:

1. The high standard of living and the contributions of chemistry
2. The exactness of chemical measurements
3. The simplicity of the metric system of measurements
4. Chemical apparatus
5. The variances of matter

### Approaches

#### Chemistry and Our Material World

How many of you know that you use chemistry or the products of chemistry in your everyday life? Perhaps you have never thought about it but you can make use of the food you have eaten only after certain chemical reactions have taken place. The car you ride in to school will run only if certain chemical reactions take place. Perhaps you have taken these things



for granted but they do not "just happen." In the first few days of chemistry we are going to study some of the ways the world has been improved through the use of chemistry.

The following activities have been given to help the teacher introduce chemistry in an interesting way.

1. Demonstration of the properties of "dry ice"
2. Construction of an "ammonia fountain"
3. Listing by each student of everyday events that have chemical significance
4. Presentation of the film on "How To Study"

#### Study Guide No. I

##### Chemistry and Our Basic Needs

1. Development of a plan of study by the student
2. A listing of those things helpful to study
3. Listing of those things that interfere with studying
4. Revision of the plan of study to include only those things beneficial to studying
5. Listing of the ways in which science has brought about changes in our mode of living
6. Listing of the fundamental needs of man
7. Listing of the contributions of chemistry toward making your recreation more interesting and enjoyable
8. Listing of the new fabrics developed by the chemist

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Biddle and Bush, Chemistry Today, (Rand McNally and Company, Chicago, 1949), pp. 5-38.

- Darrow, Floyd L., The Story of Chemistry, (Blue Ribbon Books, Inc., New York, 1930), pp. 451-460.
- Detjen and Detjen, Home Room Guidance Program for Junior High School Years, (Houghton Mifflin Company, Chicago, 1940), pp. 153-155.
- Foster, William, Romance of Chemistry, (D. Appleton-Century Company, New York, 1936), pp. 14-15, 18-21.

### How to Study Chemistry

#### I. General rules to follow for good study habits should include:

- A. A definite time for study
- B. A definite place for study and free from all distractions and interruptions
- C. A special notebook for assignments in your studies
- D. Securing all needed materials before starting to study
- E. Tackling the job immediately and trying to let nothing interfere
- F. Determining the way in which you get the best results from your studying
- G. Striving to understand what you read and remembering the thought
- H. Applying any new knowledge which you have gained
- I. Learning all materials as a whole in memorizing
- J. Cultivating the habit of mastering all work assigned daily
- K. Preparation immediately of all special reports
- L. Using the dictionary when studying
- M. Striving for good marks and not merely "passing" work
- N. Remembering that you are not working for the teacher

#### II. Specific for chemistry

- A. Studying study guide carefully
- B. Reading the assignment through once to get overall picture
- C. Restudying the study guide and determining the points covered
- D. Reading each topic in detail and answering questions in study guide

- E. Underscoring and memorizing all important statements
- F. Learning all utilized statements as important rules, principles, laws or definitions
- G. Outlining the chapter to get overall picture
- H. Learning to associate laboratory work with class discussion
- I. Checking yourself on the check sheet

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- Bennett and Hand, School and Life, (McGraw-Hill Book Company, Inc., New York, 1938), pp. 65-87.
- Detjen and Detjen, Home Room Guidance Program, (Houghton Mifflin Company, Chicago, 1940), pp. 153-155.
- Smith, Bert R., Materials given in class.

#### Subject Matter No. I

#### Chemistry and Our Basic Needs

- I. How to Study
  - A. Planning your work
    - 1. Physical and mental conditions
    - 2. Time and place for study
    - 3. Length of study period
    - 4. Developing good habits of study
  - B. Learning to concentrate
    - 1. Physical factors affecting
    - 2. Mental factors affecting
    - 3. Reading habits
    - 4. Classroom activities
  - C. Use of notebook
  - D. Recognition of important items
  - E. Memorizing

F. Reviews and examinations

II. Laboratory Procedure

A. Conduct of personnel

B. Attitude of personnel

C. Equipment

1. General
2. Supplementary
3. Cost
4. Care of
5. Method of securing

D. Chemicals

1. Handling of
2. Method of securing
3. Amounts needed
4. Unused portions

E. Use of laboratory manual

1. Following directions
2. Completion of

F. Handling of glass tubing

1. Bending
2. Cutting
3. Inserting in
  - a. Rubber tubing and stoppers
  - b. Cork

G. Use of Bunsen burner

1. Structure of
2. Adjustment of

### 3. Dangers of

## III. Chemistry and our basic needs

### A. Basic needs of man

1. The bare necessities of man
2. Those required by society

### B. Chemistry and foods

1. Increased production of foods
2. Methods of preservation of foods
3. A knowledge of nutritional values of food

### C. Chemistry and our homes

1. Improvement of construction
2. Improvement in home safety
3. Improvements in comforts of home

### D. Chemistry and clothing

1. Improvements of clothing
2. New fabrics

### E. Chemistry and health

1. Improvements in public health
2. Improvements in recreation

### F. Chemistry and communication

1. Improvements of materials
2. Improvements in methods

## Activities No. I

### Chemistry and Our Basic Needs

1. List of study aids
2. Discussion of study aids
3. List of equipment issued to you

4. Discussion of the name of each and the general use
5. First aid treatment for the common laboratory injuries
6. Practicing the technique of cutting and bending glass tubing
7. Examining the Fischer burner and learning to adjust it

#### Correlations No. I

#### Chemistry and Our Basic Needs

- I. Reading
  - A. Selecting study aids
  - B. Laboratory procedures
  - C. Chemistry's relationship to our basic needs
  - D. Specific references
- II. Mathematics
  - A. Figuring the cost of issued equipment
  - B. Gas law problems
- III. Writing
  - A. Listing study aids
  - B. Listing laboratory equipment
  - C. Writing up experiments in the laboratory
- IV. Spelling—Names of pieces of equipment such as: pipette, burette, graduate, crucible, flask, beaker, blowpipe
- V. Health
  - A. Influences in studying
  - B. First aid for injuries

#### Work Sheet No. I

#### Chemistry and Our Basic Needs

1. List the study aids you are using.
2. List the equipment that was issued to you.
3. List the basic needs of man.

Complete the following with the correct word or words.

4. The chemist often measures liquids in a glass vessel called a \_\_\_\_\_.
5. Chemicals are weighed on an instrument called a chemical \_\_\_\_\_.
6. The \_\_\_\_\_ Burner is used to heat liquids in the laboratory.
7. The \_\_\_\_\_ is used in the laboratory for holding water while collecting gases by water displacement.
8. A yellow flame on the Fischer burner indicates a lack of \_\_\_\_\_.
- 9-10. \_\_\_\_\_ and \_\_\_\_\_ are usually used when inserting glass tubing in a rubber hose or stopper to prevent friction.
11. The \_\_\_\_\_ is used in the laboratory for the exact measurement of volume.
- 12-16. The common acids found on the laboratory reagent shelf are:
  - a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_,
  - d. \_\_\_\_\_, and e. \_\_\_\_\_.
17. The \_\_\_\_\_ is used in the laboratory for burning substances at a very high temperature.
18. The \_\_\_\_\_ is used to evaporate liquids to dryness.
- 19-20. \_\_\_\_\_ and \_\_\_\_\_ are two chemicals often used in commercial fertilisers.
21. The chemical dichlorodiphenoltrichloroethane is commonly known as \_\_\_\_\_.
- 22-23. \_\_\_\_\_ and \_\_\_\_\_ are two common refrigerants used in refrigerators.

Check the following statements true or false by using (+) for true and (0) for false.

24. \_\_\_\_\_ the equipment used in the laboratory is inexpensive and easily replaced.

25. \_\_\_\_\_ Most accidents in the laboratory are caused by carelessness and thoughtlessness.
26. \_\_\_\_\_ All students have free access to the general stock of chemical supplies and equipment.
27. \_\_\_\_\_ Cleanliness of the student's equipment indicates the type of work he is doing.
28. \_\_\_\_\_ Acid burns may be treated with a weak alkali.
29. \_\_\_\_\_ Fire burns should be treated with vasoline and petroleum jelly.
30. \_\_\_\_\_ Glass tubing must be cut completely around by a file before attempting to break it.
31. \_\_\_\_\_ All fresh cut pieces of glass tubing must be fire polished.
32. \_\_\_\_\_ In bending glass tubing always heat it only on the side toward which the bend is to be made.
33. \_\_\_\_\_ In pouring acids from a reagent bottle lay the stopper on the table top in order to free both hands for handling the bottle.
34. \_\_\_\_\_ Return all unused portions of chemicals to the proper reagent bottle.
35. \_\_\_\_\_ Never turn a Fischer burner on until you have secured a lighted match.
36. \_\_\_\_\_ A bright yellow flame is the hottest flame that can be obtained on a Fischer burner.
37. \_\_\_\_\_ Chemistry has contributed much toward our comfort of living.
38. \_\_\_\_\_ Only through chemistry may we expect further improvements in materials.

Key to Work Sheet No. I

Chemistry and Our Basic Needs

4. Graduate



5. Balance
  6. Fischer
  7. Pneumatic trough
  8. Oxygen
  - 9-10. Glycerine, water
  11. Burette
  - 12-16. Sulfuric, nitric, acetic, hydrochloric
  17. Crucible
  18. Evaporating dish
  - 19-20. Sodium nitrate, calcium phosphate, potassium sulfate
  21. D.D.T.
  - 22-23. Ammonia, sulfur dioxide
- |       |       |       |
|-------|-------|-------|
| 24. 0 | 29. + | 34. 0 |
| 25. + | 30. 0 | 35. + |
| 26. 0 | 31. + | 36. 0 |
| 27. + | 32. 0 | 37. + |
| 28. + | 33. 0 | 38. + |

#### Study Guide No. II

#### The Chemist's Relationship with Matter and Energy

1. Listing the characteristics of matter
2. Preparing an experiment to explain the Law of Impenetrability
3. Preparing an experiment to show the Law of Inertia
4. Explaining the Law of Conservation of Matter
5. Listing the three states of matter and giving examples of each
6. Explaining how solids, liquids, and gases differ
7. Listing the two kinds of energy and giving examples
8. Explaining the Law of Conservation of Energy

9. Explaining the melting of a solid and liquid evaporation.
10. Naming the two kinds of properties of matter and examples of each.

#### References

- Foster, Williams, Romance of Chemistry, (D. Appleton-Century Company, New York, 1936), pp. 18-34.
- McPherson-Henderson-Fowler, Chemistry at Work, (Ginn and Company, Chicago, 1942), pp. 25, 37-40.
- Rawlins and Struble, Chemistry in Action, (D.C. Heath and Company, Boston, 1948), pp. 14-25.

#### Subject Matter No. II

#### The Chemist's Relationship with Matter and Energy

#### I. Matter

##### A. General properties

1. Impenetrability, Law of
2. Mass
3. Weight
4. Gravitation, Law of
5. Inertia
6. Indestructability, Law of Conservation of Matter
7. States of matter
  - a. Solids
  - b. Liquids
  - c. Gases

##### B. Identifying properties

1. Physical
2. Chemical

##### C. Uses of material from other sources

##### D. The scientific method

## II. Energy

- A. Definition of
- B. Conservation, Law of
- C. Forms of
  - 1. Potential
  - 2. Kinetic
    - a. Characteristics of solids
    - b. Changes in solids when melting
    - c. Characteristics of liquids
    - d. Evaporation of solids and liquids
- D. Kinds of energy
  - 1. Chemical
  - 2. Heat
  - 3. Light
  - 4. Electrical
- E. Molecular theory
  - 1. Molecules
  - 2. Atoms
  - 3. Characteristics of solids
  - 4. Melting of solids
  - 5. Characteristics of liquids
  - 6. Evaporation of solids and liquids

### Activities No. II

#### The Chemist's Relationship with Matter and Energy

- 1. Determination of the boiling point of water in the laboratory and the explanation of why it is not  $100^{\circ}\text{C}$ .
- 2. Comparison of the evaporation of ether, alcohol and water and accounting

3. Demonstration of inertia.
4. Performing an experiment to illustrate impenetrability

#### Correlations No. II

##### The Chemist's Relationship with Matter and Energy

- I. Art - Drawing diagrams for experiments
- II. Writing - Writing up each experiment
- III. Reading
  - A. Reading assigned materials
  - B. Reading specific references
  - C. Reading laboratory manuals for experimental material
- IV. Spelling - New terms in subject matter such as: kinetic, inertia, impenetrability, gravitation, physical, chemical

#### Work Sheet No. II

##### The Chemist's Relationship with Matter and Energy

Complete the following by adding the proper word or phrase to make the statement read correctly.

- 1-2. Anything may be said to be matter if it has \_\_\_\_\_ and occupies \_\_\_\_\_.
3. The principle that no two bodies may occupy the same space at the same time is known as the \_\_\_\_\_.
4. The \_\_\_\_\_ of a body is a measurement of the pull of gravity upon the body.
5. \_\_\_\_\_ is the quantity of matter in an object.
6. State Newton's Law of Gravitation.
7. A boy on a sled continues forward when the sled suddenly stops because of \_\_\_\_\_.

8. The principle that matter can neither be created or destroyed is known as the \_\_\_\_\_.
- 9-11. In what three forms may matter exist?  
a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
- 12-13. The forms of energy are a. \_\_\_\_\_,  
b. \_\_\_\_\_.
14. \_\_\_\_\_ is the capacity of a body to do work.
- 15-17. Three kinds of energy are a. \_\_\_\_\_, b. \_\_\_\_\_,  
c. \_\_\_\_\_.
- 18-22. List some of the physical properties of matter a. \_\_\_\_\_,  
b. \_\_\_\_\_, c. \_\_\_\_\_, d. \_\_\_\_\_,  
e. \_\_\_\_\_.
- 23-26. List some of the chemical properties of matter a. \_\_\_\_\_,  
b. \_\_\_\_\_, c. \_\_\_\_\_, d. \_\_\_\_\_.

Mark the following statements true or false, using the plus (+) mark for true and the zero (0) mark for false.

27. \_\_\_\_\_ A quart of water when mixed with a quart of alcohol will make one-half gallon of solution.
28. \_\_\_\_\_ Sugar and water mixed together does not follow the law of impenetrability.
29. \_\_\_\_\_ The weight of a quantity of matter will be the same at all points on the earth.
30. \_\_\_\_\_ An object will have the same mass at the South Pole and at the equator.
31. \_\_\_\_\_ An object will weigh more at the North Pole than at the equator.
32. \_\_\_\_\_ Gravitation varies directly with the mass of a body.
33. \_\_\_\_\_ The sudden pull on a rope tied to a heavy weight will cause it

to break because of inertia.

34. \_\_\_\_\_ In the burning of paper the matter is destroyed.
35. \_\_\_\_\_ In solids the molecules are less active than in gases.
36. \_\_\_\_\_ Liquids have a definite shape.
37. \_\_\_\_\_ Gases have a definite volume and shape.
38. \_\_\_\_\_ Both solids and liquids have definite volume and mass.
39. \_\_\_\_\_ Potential energy is the energy a body has due to its motion.
40. \_\_\_\_\_ Evaporation of a liquid depends upon the activity of the molecules.
41. \_\_\_\_\_ Some of the physical properties of matter can be determined by the use of the five senses.
42. \_\_\_\_\_ The chemical properties of matter are used by chemist to identify a specific substance.
43. \_\_\_\_\_ An inactive substance will not combine with another substance.
44. \_\_\_\_\_ Chemistry is a subject that is independent of all other subject fields.
45. \_\_\_\_\_ A scientific law or principle has been developed from experimentation.

#### Key to Work Sheet No. II

##### The Chemist's Relationship with Matter and Energy

- 1-2. a. weight, b. space
3. Law of Impenetrability
4. Weight
5. Mass
6. Every particle of matter in the universe attracts every other particle with a force which varies directly as the product of their masses and inversely as the square of the distance between them.

- 7. Inertia
  - 8. Law of Conservation of Matter
  - 9-11. Solids, liquids, gas
  - 12-13. Potential, Kinetic
  - 14. Energy
  - 15-17. Chemical, heat, light
  - 18-22. Color, odor, taste, solubility, freezing point, boiling point,  
density, specific gravity, specific heat
  - 23-25. Chemical activity, combustability, stability, supporter of combustion
- |       |       |       |       |
|-------|-------|-------|-------|
| 27. 0 | 32. + | 37. 0 | 42. + |
| 28. 0 | 33. + | 38. + | 43. 0 |
| 29. 0 | 34. 0 | 39. 0 | 44. 0 |
| 30. + | 35. 0 | 40. + | 45. + |
| 31. + | 36. + | 41. + |       |

### Study Guide No. III

#### Measurements

1. Listing the common units of measurements in the English system
2. Listing some of the places where the metric system of measurements are used
3. Preparation of a chart showing the similarity between the metric system of measurement and our money system
4. Memorization of the common Metric-English equivalents for length, weight, and volume
5. Measurement of length in the metric system
6. Expressing the weight of an object in the metric system
7. Studying a laboratory balance and determining its use in weighing mass

8. Listing instruments used by the chemist in measuring volume
9. Determining how these instruments are graduated and used
10. Determining the difference between the aneroid and mercurial barometers
11. Determining how these instruments measure air pressure
12. Examining a centigrade and Fahrenheit thermometer and comparing the two

#### References

- Hopkins - Davis - Smith, Chemistry and You, (Lyons and Carnahan, Chicago, 1939), pp. 758-759.
- Rawlins and Struble, Chemistry in Action, (D. C. Heath and Company, Boston, 1948), pp. 25-32.

#### Subject Matter No. III

##### Measurements

#### I. Length

##### A. English

1. Yard
2. Inch

##### B. Metric

1. Meter
2. Centimeter
3. Prefixes

#### II. Mass

##### A. English

1. Pound
2. Ounce

##### B. Metric

1. Kilogram
2. Gram
3. Prefixes



C. Balances

1. How to use
2. Scale division

III. Volume

A. English-cubic foot

B. Metric

1. Liter
2. Cubic centimeter

C. Instruments

1. Kinds
2. How to use

IV. Air Pressure

A. Barometers

1. Discovery of
2. Types
  - a. Aneroid
  - b. Mercurial
3. How to use
4. Uses of

B. Factors affecting

1. Temperature
2. Altitude
3. Moisture

V. Temperature

A. Thermometers

1. Types
  - a. Centigrade

b. Fahrenheit

2. Construction of
3. How to read

B. Conversion from centigrade to Fahrenheit and visa versa

Activities No. III

Measurements

1. Examination of a meter stick and determination of the divisions on it  
Measurement of length and width of an object in the metric and English system
2. Examination of a laboratory balance and set of weights and determination of the divisions on the scale, weighing of a text book and determining its weight in the metric system
3. Examination of the graduate and determination of how it is graduated and measuring the volume of water in a one pint bottle, determination of its volume in the metric system
4. Examination of the aneroid barometer and determination of how to read it, determination of the air pressure for the day
5. Construction of a simple mercurial barometer and a comparison of its reading with that of the aneroid barometer
6. Examination of a centigrade thermometer and practice in reading, conversion of readings to a Fahrenheit reading

Correlations No. III

Measurements

A. Mathematics

1. Conversion of metric units into English units
2. Conversion of centigrade thermometer readings into the Fahrenheit reading

3. Determining weight of objects

B. Reading

1. Reading specific references
2. Reading instruction sheets on the instruments used

C. Spelling

1. Names of equipment used such as: pipette, graduate, burette, thermometer, barometer
2. Terms used in the metric system such as: meter, centimeter, kilogram, milliliter, gram, liter

Work Sheet No. III

Measurements

Check the following statements true and false using the plus (+) sign for true and the zero (0) for false.

1. \_\_\_\_\_ The metric system of measurement is more convenient to use than the English system.
2. \_\_\_\_\_ The unit of measurement of length in the metric system is the centimeter.
3. \_\_\_\_\_ One meter is equivalent to 2.54 inches in the English system.
4. \_\_\_\_\_ The centimeter is ten times larger than the millimeter.
5. \_\_\_\_\_ The English pound is equivalent to 454 grams of the metric system.
6. \_\_\_\_\_ The laboratory balance used in the laboratory are capable of weighing to one-tenth a gram.
7. \_\_\_\_\_ Chemical balances are more accurate than the average store balances.
8. \_\_\_\_\_ It is possible to weigh the dot over an "I" on some laboratory balances.
9. \_\_\_\_\_ The burette is a device for measuring large volumes of liquids

accurately.

10. \_\_\_\_\_ The pipette is useful in measuring the volume of liquids more accurately than with a graduate.
11. \_\_\_\_\_ The volumetric flask is used principally in making up solutions of known strength.
12. \_\_\_\_\_ The unit of volume in the metric system of measurement is the milliliter.
13. \_\_\_\_\_ The barometer is a device used to measure air pressure.
14. \_\_\_\_\_ The aneroid barometer is more accurate than the mercurial barometer.
15. \_\_\_\_\_ The mercurial barometer is more convenient to use than the aneroid barometer.
16. \_\_\_\_\_ The principle of the barometer was discovered by Torricelli.
17. \_\_\_\_\_ The space above the mercury in a mercurial barometer is filled with nitrogen.
18. \_\_\_\_\_ Standard atmospheric pressure is 76 cm. of mercury.
19. \_\_\_\_\_ Normal air pressure is approximately 15 lbs. per square inch of surface.
20. \_\_\_\_\_ The air pressure will increase as the amount of water vapor in the air increases.

Complete the following to make the statement read correctly.

21. The \_\_\_\_\_ system of measurement will be used in the laboratory.
22. One meter of length is equivalent to \_\_\_\_\_ centimeters.
23. One meter of length is equivalent to \_\_\_\_\_ inches.
24. A table is 36 inches long. How many centimeters long is it? \_\_\_\_\_
25. A kilogram is equivalent to \_\_\_\_\_ grams.
26. An object weighs 908 grams. How many pounds does it weigh? \_\_\_\_\_

27. The unit of volume in the metric system of measurement is the \_\_\_\_\_.
28. The quart in the English system is approximately equal to the \_\_\_\_\_ in the metric system.
29. The unit of measurement of mass in the metric system is the \_\_\_\_\_.
30. The glass tube of a mercury barometer must be \_\_\_\_\_ inches long.
31. The \_\_\_\_\_ is used to measure the volume of a liquid to an accurate  $1/10$  of a milliliter.
- 32-33. The two types of scale readings on thermometers are (a) \_\_\_\_\_  
(b) \_\_\_\_\_.

#### Key to Work Sheet No. III

##### Measurements

1. +	6. +	11. +	16. +
2. 0	7. +	12. 0	17. 0
3. 0	8. +	13. +	18. +
4. +	9. 0	14. 0	19. +
5. +	10. +	15. 0	20. 0
21. Metric	25. 1000	29. kilogram	
22. 1000	26. 2	30. burette	
23. 39.37	27. liter	31. Fahrenheit	
24. 91.44	28. liter	32. centigrade	

#### Study Guide No. IV

##### Laws Governing Gases

1. Explanation of the pressure of gases
2. Explanation of why automobile tires often blow out on a hot day
3. State Boyles' Law
4. Explanation of the effect of pressure upon a gas volume

5. Listing the practical uses of Boyles' Law
6. Explanation of why automobile tires are filled with air
7. Relationship of temperature, the volume, and pressure of a gas
8. Development of the absolute temperature scale
9. Statement of Charles' Law
10. Discussion of pressure and its effect upon density
11. Explanation of expanding gases and the cooling of surrounding surface
12. Determination of the volume of 1000 cc of gas at 760 mm. pressure at 1520 mm. pressure
13. Determination of volume of 1000 cc of gas at 380 mm. pressure
14. Conversion of a reading of  $20^{\circ}$  C. into an absolute scale reading
15. Determining the volume of 1000 cc of gas at  $27^{\circ}$  C. changed to  $0^{\circ}$  C. at constant pressure
16. Determining the volume of 1000 cc of gas at  $-23^{\circ}$  C. when changed to  $20^{\circ}$  C. at constant pressure
17. Determining the volume of 1000 cc of gas at 780 mm. pressure and  $20^{\circ}$  C. when the pressure is changed to 740 mm. and the temperature to  $0^{\circ}$  C.

#### References

- Holmes, Barry H., Out of the Test Tube, (Emerson Books, Inc., New York, 1943), pp. 41-48.
- McPherson - Henderson - Fowler, Chemistry at Work, (Ginn and Company, Boston, 1942), pp. 41-48.
- Rawlins and Struble, Chemistry in Action, (D. C. Heath and Company, Boston, 1948), pp. 32-39.

#### Subject Matter No. IV

##### Laws Governing Gases

- I. Gas pressure - Molecular theory explanation
- II. Boyles' Law
  - A. Effect of pressure upon the volume

- B. Calculation of the change in volume with a change in pressure
- C. Calculations on changing the pressure to give a desired volume
- D. Applications of Boyles' Law
- E. Pressure and density of gases

### III. Charles' Law

- A. Influence of temperature upon the volume of gas
- B. Development of the absolute temperature scale
- C. Charles' Law
- D. Calculations of a volume of a gas at absolute temperature
- E. Calculations of change of volume of a gas with a change in temperature
- F. Calculations of how to change temperature to give a desired volume
- G. Temperature and density of gases
- H. Influence of pressure upon the temperature of gases

### IV. Combining Charles' Law and Boyles' Law

#### Activities No. IV

#### Laws Governing Gases

1. Developing an experiment to show how a change in temperature effects the volume of a gas
2. Solving problems on page 40 in Chemistry in Action by Rawlins and Strubbe

#### Correlations No. IV

#### Laws Governing Gases

### I. Mathematics

- A. Calculations based on Boyles' Law
- B. Calculations based on Charles' Law
- C. Boyles' and Charles' Law combination

- II. Reading - Specific references
- III. Writing - Experiments on effect of temperature and volume of gas
- IV. Art - Drawing of equipment set-up for experiment

Work Sheet No. IV

Laws Governing Gases

Mark the following statements true or false using the plus (+) sign for true and the zero (0) for false.

1. \_\_\_\_\_ Gas pressure is due to the motion of molecules.
2. \_\_\_\_\_ When a gas is compressed the temperature is lowered.
3. \_\_\_\_\_ If we double the pressure upon a volume of gas, its volume will be cut in half.
4. \_\_\_\_\_ We can increase the pressure of a gas by increasing the number of molecules.
5. \_\_\_\_\_ If we decrease the pressure on a gas we will decrease its volume.
6. \_\_\_\_\_ To change the volume of 500 cc. of gas to 1000 cc. at the same temperature we must double the pressure.
7. \_\_\_\_\_ When we raise the temperature of a gas we increase its pressure.
8. \_\_\_\_\_ When we raise the temperature of a gas from  $50^{\circ}\text{C.}$  to  $100^{\circ}\text{C.}$  we will double its volume.
9. \_\_\_\_\_ Ten degrees Centigrade will read  $283^{\circ}$  on the absolute scale.
10. \_\_\_\_\_ When the pressure on a gas is increased the density is increased.
11. \_\_\_\_\_ When the pressure on a gas is decreased the temperature is decreased.
12. \_\_\_\_\_ When the temperature on a gas is increased the density decreases.
13. \_\_\_\_\_ Gases are less easily compressed than liquids.
14. \_\_\_\_\_ A pressure of one atmosphere is 760 mm. of mercury at sea level.
15. \_\_\_\_\_ Standard temperature is  $273^{\circ}\text{C.}$  used in measuring volume of gases.



Complete the following:

16. State Boyles' Law
17. State Charles' Law
18. What will be the new volume of 500 cc. of gas at 740 mm. pressure when the pressure is increased to 780mm. pressure at the same temperature? \_\_\_\_\_
19. What will be the new pressure of 1000 cc. of gas at 750 mm. pressure when the volume is decreased to 500 cc. at the same temperature?
20. A change of one degree centigrade in the temperature of a gas decreases its volume \_\_\_\_\_ of its original volume.
21. At what theoretical point would the volume of a gas be reduced to zero? \_\_\_\_\_
22. The absolute temperature reading is found by adding \_\_\_\_\_ degrees to the centigrade reading.
23. What would be the absolute temperature reading when the centigrade reading is 40°? \_\_\_\_\_
24. What will be the new volume of a gas at 10° C. when the temperature is lowered to 0° C. and the original volume is 1000.
25. If a gas has a volume of 910 ml. at 0° C, to what temperature must it be heated to change its volume to 1000 ml. \_\_\_\_\_
26. What will be the new volume of 1000 cc. of gas when the pressure is changed from 750 mm. to 760 mm. and the temperature is changed from 27° C. to 20° C. \_\_\_\_\_

## Key to Work Sheet No. IV

## Laws Governing Gases

- |      |       |       |
|------|-------|-------|
| 1. + | 6. 0  | 11. + |
| 2. 0 | 7. +  | 12. + |
| 3. + | 8. 0  | 13. + |
| 4. + | 9. +  | 14. + |
| 5. 0 | 10. + | 15. 0 |
16. The volume occupied by a given weight of gas varies inversely with the pressure, provided that the temperature of a gas is kept from changing.
17. If we measure the volume of a gas at  $0^{\circ}$  C. and then change its temperature, keeping the pressure constant, the volume of the gas increases  $1/273$  of its volume at  $0^{\circ}$  for every degree the temperature is raised and decreases by  $1/273$  for every degree the temperature is lowered.
18. 474.3
19. 1510
20.  $1/273$
21.  $-273^{\circ}$  C.
22. 273
23. 313
24. 965
25.  $300^{\circ}$  A or  $37^{\circ}$  C.
26. 961

## Culminating Activities

## Chemistry and Our Material World

Let each student devise an experiment for each of the following. He will have access to reference books and laboratory manuals which are frequently found in the laboratory.

1. To acquaint the student with the metric system of measurements
  - a. Volume
  - b. Linear
  - c. Mass
2. Determining the density of a liquid and solid
3. Influence of temperature upon the volume of a gas
4. Changing the boiling point of a liquid by changing the pressure
5. Demonstrating the presence of atmospheric pressure

Desirable Outcomes

Chemistry and Our Material World

I. Knowledge and Understanding of

A. Laboratory procedure

1. Conduct of pupil

- a. No carelessness
- b. Not boisterous
- c. Not carefree
- d. Serious and sincere

2. Habits of pupil

- a. Following instructions
- b. Respecting chemicals
- c. Cleaning equipment used
- d. Returning all supplementary equipment
- e. Realizing the value of equipment
- f. Handling chemicals with care
- g. Not returning unused portions of chemicals
- h. Completing all started procedures
- i. Breaking glass tubing by first filling it

- j. Fire polishing newly cut glass
- k. Using glycerine or water when inserting glass tubing in rubber
- l. Securing a pale blue flame on burner
- m. Securing a lighted match before turning on the gas

B. Chemistry and our basic needs.

- 1. Basic needs of man
  - a. Food
  - b. Shelter
  - c. Clothing
- 2. Society additions
  - a. Health
  - b. Recreation
  - c. Transportation
  - d. Communication
- 3. Chemistry's contributions
  - a. Improvement of foods through
    - (1) Increased production
    - (2) Improving methods of preservation
    - (3) Increased nutritional knowledge
  - b. Improvement of the home
    - (1) Improving construction
    - (2) Improving home safety
    - (3) Improving comforts
  - c. Improvement of clothing
    - (1) Developing new material
    - (2) Improving old material

- d. Improvements in health
  - (1) Improving public health
  - (2) Improving recreation
- e. Improvements in communication
  - (1) Development of new materials
  - (2) Development of new methods

C. Matter

- 1. Occupies space
- 2. Possesses weight
- 3. Mass - quantity of matter
- 4. Weight
  - a. Attraction of the earth for an object
  - b. Dependent upon gravity
- 5. Newton's Law
  - a. Attraction of one body for another
  - b. Directly proportional to
    - (1) Product of masses
    - (2) Independent of size
  - c. Inversely proportional to square of the distance
- 6. Inertia
  - a. A body at rest remains at rest
  - b. A body in motion remains in motion
  - c. Until altered by outside force
- 7. Law of conservation of matter - Matter neither created nor destroyed
- 8. Forms of matter
  - a. Liquid

b. Solid

c. Gas

9. Identification of

a. Physical properties

(1) Color, odor, taste

(2) Solubility

(3) Freezing and boiling points

b. Chemical properties

(1) Chemical activity

(2) Combustibility

(3) Stability

(4) Supporter of combustion

10. Energy

a. Capacity to do work

b. Neither created nor destroyed

c. Forms

(1) Kinetic - energy in motion

(2) Potential - energy at rest

d. Kinds

(1) Chemical

(2) Heat

(3) Light

(4) Electrical

11. Molecules

a. Composition of all matter

b. In constant motion

c. Basis of chemical activity

- d. Basis of physical properties
- e. Made up of atoms

#### D. Measurements

##### 1. Systems

- a. English - general use
- b. Metric

##### (1) Scientific method

##### (2) Length

- (a) Meter - Unit of length
- (b) Centimeter -  $1/100$  of meter
- (c) Kilometer - 1000 meters

##### (3) Weight

- (a) Kilogram - Unit of mass
- (b) Gram -  $1/1000$  of kilogram

##### (4) Volume

- (a) Liter - Unit of volume
- (b) Milliliter -  $1/1000$  of liter

##### 2. Barometers

- a. Measurement of air pressure
- b. Types

##### (1) Aneroid

- (a) Most convenient
- (b) Least expensive
- (c) Less accurate

##### (2) Mercury

- (a) Most accurate
- (b) Inconvenient
- (c) Expensive

### 3. Thermometers

a. Measurement of temperature

b. Types

(1) Fahrenheit

(2) Centigrade

(a)  $100^{\circ}$  boiling point of water

(b)  $0^{\circ}$  freezing point of water

c. Conversion factors

$$(1) C^{\circ} = (F^{\circ} - 32) \times 5/9$$

$$(2) F^{\circ} = C^{\circ} \times 9/5 + 32$$

### E. Boyle's and Charles' Law

1. Application to gases only

2. Production of pressure

a. Number of molecules

b. Motion of molecules

3. Boyle's Law

a. Volume of gases

(1) Varies inversely with pressure

(2) New volume = old volume  $\times$  pressure fraction

$$(3) V_2 = V_1 \times \frac{P_1}{P_2}$$

(4) Practical uses

(a) Pneumatic hammer

(b) Drills

(c) Chisels

(d) Air brakes

(5) Increasing pressure

(a) Increases density



## (b) Decreases volume

## 4. Charles' Law

## a. Volume of gases

(1) Varies directly with temperature

(2) New volume = old volume x temperature fraction

$$(3) V_2 = V_1 \times \frac{T_2}{T_1}$$

(4) Temperature - absolute reading

(5) Absolute temperature = centigrade reading + 273

$$(6) T_A = T_C + 273$$

## 5. Combination of two laws

$$V_2 = \frac{T_2}{T_1} \times \frac{P_1}{P_2}$$

## II. Attitude towards:

## A. Respect for

1. Improving the quantity and quality of food
2. Improvements of the home
3. Improvements of clothing
4. Improvements of health

## B. Respect for the training

1. Neatness
2. Accuracy
3. Completeness
4. Seeking the truth

## C. Applying the knowledge to everyday living

## D. Improving your work and accomplishing more by being systematic in your work

## III. Habit of:

- A. Understanding what you are doing or going to do
- B. Seeking needed information on your own initiative and requesting aid when you have a need
- C. Being neat in all work
- D. Being accurate in all work
- E. Completing an experiment before continuing to the next
- F. Using references freely
- G. Finding practical application of knowledge
- H. Writing up all experiments
- I. Reading the study guides
- J. Being efficient in all your work

## IV. Appreciation for:

- A. The contributions of chemistry in improving your daily living
- B. The explanation of chemistry for certain phenomena
  - 1. Effects of pressure on a gas
  - 2. Effects of temperature on a gas
  - 3. Pressure of gases
  - 4. Existence of matter in a liquid, solid, and gas forms
- C. The metric system of measurements
- D. The laboratory and its equipment
- E. Good workmanship
- F. Chemistry in the various vocations and avocations
- G. Good study habits
- H. Good study aids

### Leads to Other Units

#### Chemistry and Our Material World

It is hoped that through this introductory unit the chemistry student has developed an interest in chemistry and realizes that chemistry has made a vast contribution to the improvements in the life of men. The student should be aware of the fact that the knowledge of chemistry has many practical applications and can be used in many vocations and avocations. The student should have developed an interest in chemistry and a desire to continue increasing his knowledge through a study of the following units.

- II. A Chemical View of Matter
- III. The Structure of Matter
- IV. Theory of Solutions
- V. Nitrogen and Its Compounds
- VI. The Wonder Element Carbon
- VII. The Periodic Law and Chemical Families
- VIII. Some Important Non-Metals
- IX. The Metals

Teacher Evaluation  
Chemistry and Our Material World

To what extent does the unit:	Ex.	V.G.	G.	F	P.	None
1. Involve a variety of direct sensory experiences?		✓				
2. Provide for free informal association of pupils?	✓					
3. Provide an opportunity for manipulative activity?	✓					
4. Make a coherent whole?		✓				
5. Provide a considerable amount of student activity?		✓				
6. Produce satisfying outcomes?			✓			
7. Provide sufficient concrete and illustrative material?			✓			
8. Have a useful purpose in the present and future life of the pupils?			✓			
9. Reproduce actual life situations as far as possible?			✓			
10. Utilize materials as they occur in life?			✓			
11. Contain some accurate material?	✓					

12. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?
13. Provide opportunity to judge, choose and evaluate?
14. End of lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete, exact references?

Ex.	V.G.	G.	F.	P.	None
		✓			
	✓				
✓					
	✓				
✓					
✓					

### Pupil Test

### Knowledge Test

### Chemistry and Our Material World

Complete the following statements with the correct word or phrase to make them read correctly.

1. The chemist often measures liquids in a glass vessel called a \_\_\_\_\_.
2. The rounded upper surface of a liquid in a narrow cylindrical vessel is called a \_\_\_\_\_.
3. Chemicals are weighed on an instrument called a chemical \_\_\_\_\_.
4. Quantities of a chemical up to \_\_\_\_\_ g. can be weighed without weights by making use of the sliding.

5. The smallest scale division on my graduate is equal to \_\_\_\_\_ ml.
6. When measuring water the meniscus is (concave, convex) \_\_\_\_\_.
7. The instrument used to scratch glass tubing before breaking it at a certain point is the \_\_\_\_\_.
8. The sharp or jagged edges of glass tubing may be smoothed by \_\_\_\_\_.
9. When inserting glass tubing through a rubber stopper \_\_\_\_\_ or \_\_\_\_\_ should be used to decrease friction.
10. Substances may be identified through a study of their \_\_\_\_\_ and properties.
11. It is not safe to taste unknown substances because some substances are \_\_\_\_\_.
12. Two units of volume and weight in the metric system are the \_\_\_\_\_ and the \_\_\_\_\_ respectively.
13. Two units of length in the metric system are the \_\_\_\_\_ and the \_\_\_\_\_.
14. The density of water at \_\_\_\_\_  $^{\circ}\text{C}$ . is \_\_\_\_\_ g. per ml., that is one ml. of water at \_\_\_\_\_  $^{\circ}\text{C}$  weighs \_\_\_\_\_ g.
15. If a gas is heated at a constant pressure it \_\_\_\_\_.
16. If a gas is cooled at a constant pressure it \_\_\_\_\_.
17. Water will boil at a temperature lower than  $100^{\circ}\text{C}$ . if the pressure on it is \_\_\_\_\_.
18. To raise the boiling point of water you must \_\_\_\_\_ the pressure upon it.
19. Three fundamental needs of man are 1. \_\_\_\_\_, 2. \_\_\_\_\_, and 3. \_\_\_\_\_.
20. Foods that have had the water removed are called \_\_\_\_\_ foods.

21. Two synthetic materials used in making cloth for clothing are \_\_\_\_\_ and \_\_\_\_\_.
22. Any substance that occupies \_\_\_\_\_ and has \_\_\_\_\_ is classified as matter.
23. \_\_\_\_\_ is the quantity of matter in an object.
24. A person continues to move forward when a car suddenly stops because of his \_\_\_\_\_.
25. Matter may exist in three forms \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
26. \_\_\_\_\_ is the energy a body has due to its motion.
27. \_\_\_\_\_ is the energy a body has due to its position.
28. A length of 90 cm. is equivalent to \_\_\_\_\_ meters.
29. One (1) inch of length is equivalent to \_\_\_\_\_ cm.
30. A mass of 500 grams is equivalent to \_\_\_\_\_ kilograms.
31. The \_\_\_\_\_ is an instrument used in measuring air pressure.
32. The \_\_\_\_\_ barometer is the most accurate barometer to use.
33. The pressure of a gas is due to the motion of the \_\_\_\_\_ in the gas.
34. The boiling point of water is 100 degrees on the \_\_\_\_\_ thermometer.
35. A temperature reading of  $10^{\circ}$  C. will read \_\_\_\_\_ degrees on the Fahrenheit thermometer.
36. A temperature reading of  $50^{\circ}$  F. will be \_\_\_\_\_  $^{\circ}$  on the Centigrade thermometer.
37. \_\_\_\_\_ Law states that at a constant temperature the volume of a gas varies inversely with the pressure.
38. What will be the new volume of a gas which occupies 400 ml. at 740 mm.

when the pressure is changed to 770 mm. pressure? \_\_\_\_\_.

39. \_\_\_\_\_ Law states that at a constant pressure the volume of a gas varies directly with the change in temperature.
40. What will be the new volume of a gas which occupies 400 ml. at 760 mm. pressure and  $20^{\circ}$  C. when the temperature is changed to  $30^{\circ}$  C.?
- \_\_\_\_\_

Mark the following statements true or false as the statements will read using the plus (+) for true and the zero (0) sign for false.

- \_\_\_\_\_ 1. The density of a gas increases as the temperature increases.
- \_\_\_\_\_ 2. When a gas is allowed to expand its temperature is decreased.
- \_\_\_\_\_ 3. The density of a gas decreases as the pressure on the gas decreases.
- \_\_\_\_\_ 4. An increase in the temperature of a gas brings about an increase in the pressure of the gas.
- \_\_\_\_\_ 5. The pressure of a gas is due to the motion of the molecules.
- \_\_\_\_\_ 6. The glass tube of the aneroid barometer is filled with mercury.
- \_\_\_\_\_ 7. The centigrade thermometer is more convenient to use than the Fahrenheit thermometer.
- \_\_\_\_\_ 8. The principle of the barometer was discovered by Galileo.
- \_\_\_\_\_ 9. The millimeter is ten times as big as the centimeter.
- \_\_\_\_\_ 10. One centimeter is equivalent to 2.54 inches.
- \_\_\_\_\_ 11. One pound in the English system is equal to 454 grams in the metric system.
- \_\_\_\_\_ 12. To melt a solid, the motion of the molecules must be increased.
- \_\_\_\_\_ 13. The faster an object moves the more potential energy it possesses.
- \_\_\_\_\_ 14. When a piece of paper is burned the matter is destroyed.
- \_\_\_\_\_ 15. The faster an object moves the more inertia it will possess.



- \_\_\_\_ 16. The weight of an object will vary with the force of gravity.
- \_\_\_\_ 17. Nylon is a synthetic product made by chemist and used in making cloth.
- \_\_\_\_ 18. Dehydrated foods have had much of their food value removed.

### Key to Knowledge Test

#### Chemistry and Our Material World

##### Completion

- |                                      |                        |
|--------------------------------------|------------------------|
| 1. Graduate                          | 21. Nylon, rayon       |
| 2. Miniscus                          | 22. Space, weight      |
| 3. Balance                           | 23. Mass               |
| 4. Ten                               | 24. Inertia            |
| 5. One tenth                         | 25. Solid, liquid, gas |
| 6. Concave                           | 26. Kinetic            |
| 7. Triangle file                     | 27. Potential          |
| 8. Fire polishing                    | 28. .9                 |
| 9. Water, glycerine                  | 29. 2.54               |
| 10. Chemical, physical               | 30. 1/2                |
| 11. Toxic                            | 31. Barometer          |
| 12. Liter, milliliter, gram kilogram | 32. Mercury            |
| 13. Meter, centimeter                | 33. Molecules          |
| 14. 4,1; 4,1                         | 34. Centigrade         |
| 15. Expands                          | 35. 40                 |
| 16. Contracts                        | 36. 15                 |
| 17. Decreased                        | 37. Boyles'            |
| 18. Increase                         | 38. 384.4              |
| 19. Food, clothing, shelter          | 39. Charles'           |
| 20. Dehydrated                       | 40. 413.6              |

## True and False

1. 0	7. +	13. 0
2. +	8. 0	14. 0
3. +	9. 0	15. +
4. +	10. 0	16. 0
5. +	11. +	17. +
6. 0	12. +	18. 0

## Pupil Test

## Attitude Test

## Chemistry and Our Material World

Answer the following questions by placing a yes or no before each statement.

- \_\_\_\_\_ 1. Do you think we could have all our modern equipment without chemistry?
- \_\_\_\_\_ 2. Do you think it would be easier to use the metric system in everyday uses instead of the English system?
- \_\_\_\_\_ 3. Do you think the metric system is more practical than the English system?
- \_\_\_\_\_ 4. Do you like to do your work accurately?
- \_\_\_\_\_ 5. Do you like to do your work completely in every detail?
- \_\_\_\_\_ 6. Do you like to have your work definitely planned?
- \_\_\_\_\_ 7. Do you think chemistry has played an important part in improving our foods?
- \_\_\_\_\_ 8. Do you think chemistry will lead to further improvements in the future?
- \_\_\_\_\_ 9. Do you think a knowledge of chemistry will aid you in the future?
- \_\_\_\_\_ 10. Does the knowledge of the principle of Charles' Law help you understand certain practical uses of gases?

- \_\_\_\_ 11. Do you feel that a knowledge of chemistry can be applied to certain everyday phenomena?
- \_\_\_\_ 12. Do you think a knowledge of the principle of Boyles' Law helps you to explain certain principles you have wondered about?
- \_\_\_\_ 13. Do you think a knowledge of chemistry will make you a better consumer in the future?
- \_\_\_\_ 14. Do you feel that chemistry will develop better insecticides in the future?
- \_\_\_\_ 15. Do you feel that our clothing has been improved through chemistry?
- \_\_\_\_ 16. Will a knowledge of plastics aid you in selecting cloth in the future?
- \_\_\_\_ 17. Has chemistry aided in improving farming and improved the economic status of the farmer?
- \_\_\_\_ 18. Does a knowledge of the law of impenetrability help you to explain certain natural phenomena?
- \_\_\_\_ 19. Does a knowledge of the changes of matter help to explain what happens in certain phenomena?
- \_\_\_\_ 20. Do you understand how the barometer is used to help determine the weather?
- \_\_\_\_ 21. Do you like to seek the explaining principles back of natural phenomena?
- \_\_\_\_ 22. Do you feel that a knowledge of the principle of energy can help you explain how some objects can do more work than others.
- \_\_\_\_ 23. Do you enjoy applying the knowledge of chemistry to everyday events?
- \_\_\_\_ 24. Do you enjoy the ability to explain why certain chemicals behave as they do?

- \_\_\_\_ 25. Do you feel that a knowledge of chemistry will help you appreciate the modern equipment in the home?

Pupil Test

Habit Test

### Chemistry and Our Material World

Mark the following statements according to the way you do them. If you do them place a plus (+) sign in front, if you don't place a zero (0) sign.

- \_\_\_\_ 1. Do you schedule your time for each day's activity?
- \_\_\_\_ 2. Do you plan your day's activities?
- \_\_\_\_ 3. Do you have a definite study plan to be followed?
- \_\_\_\_ 4. Do you follow directions completely?
- \_\_\_\_ 5. Do you do your work completely and thoroughly?
- \_\_\_\_ 6. Are you neat in your work?
- \_\_\_\_ 7. Do you always put glycerine or water on glass tubing before putting it in a stopper?
- \_\_\_\_ 8. Do you fire polish all fresh cut edges of glass tubing?
- \_\_\_\_ 9. Do you keep all your equipment clean when it is not in use?
- \_\_\_\_ 10. Do you weigh out the exact amount of chemicals needed?
- \_\_\_\_ 11. Do you make certain that you understand the experiment before you attempt to do it?
- \_\_\_\_ 12. Do you return all unused portions of chemicals to the reagent bottles?
- \_\_\_\_ 13. Do you lay the acid bottle tops on the laboratory table top while securing an acid?
- \_\_\_\_ 14. Do you put insoluble substances in the sinks?
- \_\_\_\_ 15. Do you accurately measure all substances needed in an experiment?
- \_\_\_\_ 16. Do you write up completely all laboratory experiments?

- \_\_\_\_ 17. Do you apply the knowledge of chemistry you have to everyday events?
- \_\_\_\_ 18. Do you apply Boyles' Law in explaining gas pressure in an automobile tire?
- \_\_\_\_ 19. Do you use Charles' Law to explain why tires blow out on a hot day?
- \_\_\_\_ 20. Do you use the kinetic theory of gases to explain gas pressure?
- \_\_\_\_ 21. Do you use the principle of impenetrability to explain why two objects cannot be in the same place at the same time?
- \_\_\_\_ 22. Do you use the laws of gravity to explain why it takes longer to boil an egg on a hill than in a valley?
- \_\_\_\_ 23. Do you try to use the knowledge of chemistry to explain the principle of refrigeration?
- \_\_\_\_ 24. Do you use the molecular theory to explain the evaporation of liquids?
- \_\_\_\_ 25. Do you use the law of conservation of energy to explain the energy changes made in a car engine?

#### Key to Habit Test

#### Chemistry and Our Material World

The desirable answer to the questions is a plus (+) for all except for nos. 12, 13, 14 which should be zero (0).

#### Pupil Test

#### Appreciation Test

#### Chemistry and Our Material World

Check the following questions with a yes or no in front of each one.

- \_\_\_\_ 1. Do you appreciate the contributions of chemistry to our present day standard of living?

- \_\_\_\_\_ 2. Do you appreciate the knowledge of chemistry you have gained already which helps you explain certain phenomena?
- \_\_\_\_\_ 3. Do you appreciate the use of experiments in helping you understand the principle of chemistry studied?
- \_\_\_\_\_ 4. Do you appreciate the exactness of chemistry?
- \_\_\_\_\_ 5. Do you appreciate the simplicity of the metric system of measurements?
- \_\_\_\_\_ 6. Do you appreciate the equipment you use in the laboratory?
- \_\_\_\_\_ 7. Do you appreciate the advantages of well planned work?
- \_\_\_\_\_ 8. Do you appreciate the explanation of gas pressure by the kinetic theory of gases?
- \_\_\_\_\_ 9. Do you appreciate the use of the barometer in determining gas pressure?
- \_\_\_\_\_ 10. Do you appreciate the use of the barometer in determining gas pressure?
- \_\_\_\_\_ 11. Do you appreciate the simplicity of the scale on the centigrade thermometer?
- \_\_\_\_\_ 12. Do you appreciate the contributions of chemistry to the field of recreation?
- \_\_\_\_\_ 13. Do you appreciate the fact that matter exists in various forms so we can make many uses of it?
- \_\_\_\_\_ 14. Have you developed an appreciation for chemistry?
- \_\_\_\_\_ 15. Have you developed an appreciation for the use of chemistry knowledge in broadening your knowledge?

#### Key to Appreciation Test

#### Chemistry and Our Material World

Desirable answers for the appreciation test are yes for all statements.

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UNIT NO. II  
A CHEMICAL VIEW OF MATTER

Chemists have done much to give us a clear and orderly understanding of our material world. They have worked out a classification of matter, based on chemical composition, whereby all substances fall into three groups. They have found out that there are only two general kinds of changes in matter, physical and chemical, and they have devoted their energies mostly to the latter kind of change.

You will find that they have reached an understanding of chemical changes, their causes, and how to control or modify them. The understanding of chemical changes enables chemists to isolate needed elements and to prepare useful compounds and mixtures.<sup>5</sup>

This unit also deals with the element oxygen: its major properties, its commercial uses, and the methods of obtaining it in purer form than that in which it occurs in air. Hydrogen also is an important part of the discussion in this unit because this element is associated with oxygen as a part of our most important compound, namely water.

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<sup>5</sup> Rawlins and Struble, Chemistry in Action, (D. C. Heath and Company, Boston, 1948), p. 45.



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## A Chemical View of Matter

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### Criteria for the Evaluation of a Unit<sup>6</sup>

#### A Chemical View of Matter

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal association of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilise materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupil to originate, plan, and direct the activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.

<sup>6</sup>

Harap, Western Reserve Bulletin, No. 17.

15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be obtained.
17. When references are given they should be complete and exact.

Grade Placement - - Eleventh or Twelfth

Time Allotment - - Twenty days

Central Theme - - Classification of Matter

### Objectives

#### A Chemical View of Matter

##### A. Knowledge and Understanding of:

1. Characteristics of matter
2. Two common elements, oxygen and hydrogen
3. Water as a typical compound
4. Air as a mixture

##### B. Attitude toward:

1. Correct study habits
2. Usefulness of the characteristics of matter
3. Benefits from the changes in matter
4. Respect for the work of the chemist in studying matter
5. The study of hydrogen and oxygen as typical elements
6. The nature of compounds as illustrated by water
7. The nature of mixtures as illustrated by air

##### C. Habit of:

1. Using knowledge of the first unit while studying this unit
2. Associating the characteristics of oxygen and hydrogen with other elements.

3. Using the classification of matter in predicting the properties of elements by experimentation
  4. Verifying the properties of elements by experimentation
  5. Performing experiments completely and neatly
  6. Summarizing important facts
  7. Distinguishing between compounds and mixtures
  8. Using study guides carefully
- B. Appreciation for:
1. The classification of matter
  2. An understanding of the element oxygen
  3. The variances of matter and an abundant number of compounds
  4. The understanding of water and its uses
  5. A knowledge of mixtures such as air
  6. Laboratory experiments
  7. Accurate work
  8. Good study habits

#### Approaches

##### A Chemical View of Matter

This unit may be effectively introduced by:

- A. Making an exhibit of the different elements
- B. Making a list of the elements in the body and the earth's crust
- C. Illustrating the changes in matter and the properties of oxygen
- D. Illustrating the differences between a mixture and a compound, such as, iron and sulfur and iron sulfide
- E. Illustrating the formation of water

#### Study Guide No. I

##### Characteristics of Matter

- A. Preparation of a list of the elements in the human body
- B. Preparation of a list of the nine most abundant elements
- C. Preparation of a list of several elements showing solids, liquids, and gases
- D. Preparation of a list of the main chemical reactions
- E. Explanation of the difference between chemical and physical changes
- F. Preparation of a list of the formulas for the elements in the body
- G. Explanation of the between a compound, mixture, and element
- H. Illustration of each type of chemical reaction
- I. Classification of the following as elements, compounds, or mixtures:  
soil, hydrogen, tincture of iodine, sand, breakfast cereal, hair tonic, lithium, carbon monoxide, tooth powder, steam, and gold
- J. Explanation of the difference between qualitative analysis

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#### Subject Matter No. I

#### Characteristics of Matter

#### I. Classification of Matter

##### A. Elements

- 1. Definition of
- 2. Number of
- 3. Naming of
- 4. Kinds of

- a. Non metals

- b. Metals

- c. Amphoteric

- d. Inert

- 5. Characteristics of

- a. Non metals

- b. Metals

- B. Compounds

- 1. Definition of

- 2. Formation of

- 3. Combining of elements by Dalton's Atomic Theory

- 4. Dalton's Law or the Law of Definite Proportions

- 5. Symbols and their uses

- 6. Chemical formulas and their uses

- C. Mixtures

- 1. Definition of

- 2. Differences of compounds

- 3. Difference of elements

- II. Changes in Matter

- A. Physical changes

- 1. Definition of

- 2. Examples of

- a. Sublimation

- b. Fusion and melting

- c. Evaporation and vaporization

- B. Chemical changes

- 1. Definition of

2. Energy involved
3. Types of chemical reactions
  - a. Combination or synthesis
  - b. Use of chemical equations
  - c. Decomposition or analysis
  - d. Single replacement or substitution
  - e. Double replacement or substitution or decomposition
  - f. Polymerization

#### Activities No. I

##### Characteristics of Matter

- A. Completing the questions on pages 52-53, 59-60 of Chemistry in Action, Rawlins and Struble
- B. Drawing a graph showing the most abundant elements of the earth and give their percentages
- C. Having each student develop an experiment for:
  1. Difference between element, compound, and mixture
  2. To show a chemical change
  3. To show a physical change
  4. To show a decomposition reaction
  5. To show a combination reaction
  6. To show a replacement reaction

#### Correlations No. I

##### Characteristics of Matter

- A. Reading
  1. Specific references
  2. Laboratory manuals for laboratory procedure
- B. Spelling new terms: analysis, element, non metals, amphoteric, symbols,



sublimation, fusion, evaporation, vaporization, polymerization

C. Writing

1. Procedures for experiments
2. Answering assigned questions

D. English

1. Oral discussion
2. Meaning of new terms: analysis, element, non metal, amphoteric, symbols, sublimation fusion, evaporation, vaporization, polymerization.

E. Art - Diagrams for equipment setup of experiments

Work Sheet No. I

Characteristics of Matter

Complete the following statements

1. An \_\_\_\_\_ is a simple substance which cannot be broken up into any simpler substance by ordinary chemical means.
2. There are \_\_\_\_\_ known elements.
3. Nearly all the metallic elements have the ending \_\_\_\_\_ on their names.
4. The four groups of elements are a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_, and d. \_\_\_\_\_.
5. The two most abundant elements on the earth are a. \_\_\_\_\_, b. \_\_\_\_\_.
6. \_\_\_\_\_ elements are those that exhibit properties of both metals and non metals.
7. \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ are three inert elements.
8. A \_\_\_\_\_ is a substance composed of two or more elements combined in a definite ratio.

9. Dalton's First Law states that \_\_\_\_\_.
10. A sign or letter used to designate an element is called a \_\_\_\_\_.
11. When two or more symbols are put together to represent a compound they are called a \_\_\_\_\_.
12. The letters "Cu" represent a \_\_\_\_\_ while the letters "CuO" represent a \_\_\_\_\_.
13. A \_\_\_\_\_ is an association of chemicals in an uncombined state and in no definite proportion.
14. A chemical change causes the formation of \_\_\_\_\_ substances with \_\_\_\_\_ properties.
15. When a substance undergoes a chemical change its composition \_\_\_\_\_.
16. The change of ice to water is a \_\_\_\_\_ change.
17. The rusting of iron is a \_\_\_\_\_ change.
18. The evaporation of gasoline is a \_\_\_\_\_ change.
19. The dissolving of sugar in water is a \_\_\_\_\_ change.
20. In a compound the elements \_\_\_\_\_ their individual properties.
21. In a mixture the elements \_\_\_\_\_ their individual properties.
22. A compound is the result of a \_\_\_\_\_ change.
23. A mixture is the result of a \_\_\_\_\_ change.
24. The iron may be removed from a mixture of sulphur and iron powder by using a \_\_\_\_\_.
25. Energy changes usually accompany chemical changes. Examples of forms of energy are a. \_\_\_\_\_ b. \_\_\_\_\_.
26. Determine whether the following reactions are either: Combination, decomposition, single replacement, double replacement or polymerisation.
- \_\_\_\_\_ a.  $\text{Copper} + \text{oxygen} \longrightarrow \text{copper oxide}$

- \_\_\_\_\_ b. Mercuric oxide  $\xrightarrow{\text{heat}}$  mercury + oxygen
- \_\_\_\_\_ c. Hydrogen + oxygen  $\xrightarrow{\text{heat}}$  hydrogen oxide
- \_\_\_\_\_ d. Zinc + copper sulfate  $\longrightarrow$  copper + zinc sulfate
- \_\_\_\_\_ e. Silver nitrate + sodium chloride  $\longrightarrow$  silver chloride + sodium nitrate

27. Represent the above equations by the use of formulas instead of the names.

- a.  
b.  
c.  
d.  
e.

28. Rubber is the result of the \_\_\_\_\_ of isoprene.

29. \_\_\_\_\_ is the changing of a solid into a gas without first melting.

30. \_\_\_\_\_ is the changing of a solid into a liquid.

31. \_\_\_\_\_ is the changing of a liquid into a gas.

#### Key to Work Sheet No. I

#### Characteristics of Matter

- |                 |  |
|-----------------|--|
| 1. Element      | 6. Amphoteric  |
| 2. 96           | 7. Argon, neon, helium, xenon, krypton                 |
| 3. 14           | 8. Compound  |
| 4. a. Non metal | 9. Every compound has a definite composition by weight |
| b. Metal        | 10. Symbol   |
| c. Amphoteric   | 11. Formula  |
| d. Inert        | 12. Symbol - formula                                   |
| 5. a. Oxygen    |  |
| b. Silicon      |  |

- |                             |  |
|-----------------------------|--|
| 13. Mixture                 | 26. a. Composition   |
| 14. New, new                | b. Decomposition   |
| 15. Changes                 | c. Composition   |
| 16. Physical                | d. Replacement   |
| 17. Chemical                | e. Double replacement  |
| 18. Physical                | 27. a. $2\text{Cu} + \text{O}_2 \longrightarrow 2\text{CuO}$                 |
| 19. Physical                | b. $2\text{H}_2\text{O} \longrightarrow 2\text{H}_2 + \text{O}_2$            |
| 20. Lose                    | c. $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$            |
| 21. Retain                  | d. $\text{Zn} + \text{CuSO}_4 \longrightarrow \text{Cu} + \text{ZnSO}_4$     |
| 22. Chemical                | e. $\text{AgNO}_3 + \text{NaCl} \longrightarrow \text{NaNO}_3 + \text{AgCl}$ |
| 23. Physical                | 28. Polymerization   |
| 24. Magnet                  | 29. Sublimation  |
| 25. Heat, light, electrical | 30. Fusion   |
|                             | 31. Evaporation  |

### Study Guide No. II

#### Hydrogen and Oxygen

1. Discussion of the discovery of oxygen
2. Explanation of the preparation of oxygen
3. Explanation of the commercial preparation of oxygen
4. Description of the commercial preparation of hydrogen
5. Description of the physical properties of oxygen
6. Description of the chemical properties of oxygen
7. Definition of oxidation
8. Equations showing the action of oxygen on copper, carbon, magnesium, and sulfur
9. Discussion of how to control oxidation
10. Discussion of the conditions necessary of burning

11. Discussion of the causes of most fires
12. Discussion of the uses of oxygen
13. Discussion of the discovery of hydrogen
14. Discussion of the preparation of oxygen
15. Discussion of metals and their ability to replace hydrogen from the common acids
16. Discussion of the physical properties of hydrogen
17. Discussion of the chemical properties of hydrogen
18. Discussion of the uses of hydrogen
19. Definition of catalyst, reduction, and hydrogenation
20. Explanation of the terms combustible, supporter of combustion, non-combustible, spontaneous combustion, and kindling temperature

#### References

- Foster, The Romance of Chemistry, pp. 58-78, 161-172.  
Holmes, Out of the Test Tube, pp. 72-78.  
Rawlins and Struble, Chemistry in Action, pp. 60-77.  
Biddle and Bush, Chemistry Today, pp. 43-71.

#### Subject Matter No. II

#### Hydrogen and Oxygen

##### I. Oxygen

##### A. Discovery of

1. Priestley
2. Lavossier
3. Heating of mercuric oxide

##### B. Sources of

##### C. Preparation of

1. Laboratory

- a. Heating of potassium chlorate
  - b. Use of manganese dioxide
  - c. Catalyst
  - d. Equations
  - e. Reasons for use of potassium chlorate
  - 2. Commercial
    - a. Electrolysis of water
    - b. Distillation of liquid air
  - D. Properties of
    - 1. Physical
    - 2. Formula for
    - 3. Chemical
      - a. Oxidation
      - b. Equations for oxidation
      - c. Kindling temperature
      - d. Identification of
  - E. Ozons
    - 1. Formation of
    - 2. Properties of
      - a. Chemical
      - b. Physical
  - F. Factors affecting oxidation
  - G. Conditions necessary for burning
  - H. Causes of fires
  - I. Commercial uses of oxygen
- II. Hydrogen
- A. Discovery of

- B. Occurrence of
- C. Preparation of
  - 1. Laboratory
    - a. Electrolyses of water
    - b. Active metals and water
      - (1) Sodium
      - (2) Potassium
      - (3) Lithium
      - (4) Equations for reaction
    - c. Iron and steam
    - d. Acids on metals
      - (1) Catalyst
      - (2) Equations for reactions
  - 2. Commercial
    - a. Electrolysis of water
    - b. Bosch method
- D. Metals and hydrogen replacement
- E. Properties of
  - 1. Physical
  - 2. Formula of
  - 3. Chemical
- F. Uses of
  - 1. Fuels
  - 2. Reduction
  - 3. Lighter than air craft
  - 4. Hydrogenation

# Activities No. II

## Hydrogen and Oxygen

- A. Completion of the questions on pages 76-77, Rawlins and Struble,

### Chemistry in Action

- B. Preparation of oxygen in the laboratory  
C. Preparation of an experiment to show oxidation control  
D. Preparation of hydrogen in the laboratory

## Correlations No. II

### Hydrogen and Oxygen

#### A. Reading

1. Specific references
2. Laboratory manuals for laboratory experiments

- B. Spelling of new terms: phlogiston, catalyst, oxidation, diffusion  
C. English - Meaning of new terms: phlogiston, catalyst, oxidation, diffusion  
D. Art - Drawings of equipment setups in laboratory experiments  
E. Writing up the experiments

## Work Sheet No. II

### Hydrogen and Oxygen

Complete the following statements to make them read correctly.

1. \_\_\_\_\_ is usually given the credit for discovering oxygen.
2. Up until the discovery of oxygen, burning was explained by the \_\_\_\_\_ theory.
3. The gas oxygen was named by the chemist \_\_\_\_\_.
4. Complete the equations
  - a.  $2 \text{ Hg} + \text{O}_2 \longrightarrow$
  - b.  $2 \text{ H}_2\text{O} \xrightarrow{\text{A}} \text{ >}$



5. Write the equation for the laboratory preparation of oxygen. \_\_\_\_\_  
\_\_\_\_\_.
6. A substance that accelerates a chemical reaction without being changed itself is called a \_\_\_\_\_.
7. Oxygen is prepared commercially by either of two methods a. \_\_\_\_\_  
b. \_\_\_\_\_.
8. Three physical properties of oxygen are a. \_\_\_\_\_,  
b. \_\_\_\_\_, c. \_\_\_\_\_.
9. The combining of oxygen with any other substance is called \_\_\_\_\_.
10. Complete the following equations  
a.  $2 \text{Mg} + \text{O}_2 \longrightarrow$   
b.  $\text{C} + \text{O}_2 \longrightarrow$   
c.  $4\text{P} + 5\text{O}_2 \longrightarrow$
11. The lowest temperature at which a substance will burn is known as its  
\_\_\_\_\_.
12. Ozone contains \_\_\_\_\_ atoms of oxygen.
13. In what three ways may oxidation be increased a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_
14. What three things are needed before burning may take place a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_
15. \_\_\_\_\_ and \_\_\_\_\_ are two uses of oxygen.
16. \_\_\_\_\_ was the first man to discover hydrogen.
17. Write the equations for the laboratory preparation of hydrogen from an active metal, and water, steam and iron, metal and acid.
18. \_\_\_\_\_ is used as a catalyst in the laboratory preparation of hydrogen.
19. Hydrogen is prepared commercially by either of the two methods  
a. \_\_\_\_\_ and b. \_\_\_\_\_.

20. Hydrogen unites with oxygen to form \_\_\_\_\_.
21. The process of removing oxygen from oxides by hydrogen is called \_\_\_\_\_.
22. The adding of hydrogen to liquid fats or oils to make solid fats or oils is called \_\_\_\_\_.

Mark the following statements true or false using the plus (+) sign for true and the zero (0) sign for false.

23. \_\_\_\_\_ Hydrogen supports combustion.
24. \_\_\_\_\_ Hydrogen is the lightest gas.
25. \_\_\_\_\_ Hydrogen is not safe to use in blimps because it readily burns.
26. \_\_\_\_\_ All metals will liberate hydrogen from acids.
27. \_\_\_\_\_ Hydrogen is very soluble in water.
28. \_\_\_\_\_ Manganese dioxide was used as a catalyst in the preparation of hydrogen.
29. \_\_\_\_\_ By volume there is twice as much hydrogen as oxygen in water.
30. \_\_\_\_\_ Sodium may be stored under water to prevent oxidation.
31. \_\_\_\_\_ Oxygen oxidizes the food in our body.
32. \_\_\_\_\_ Oxygen readily burns when a lighted match is put in it.
33. \_\_\_\_\_ Ozone is a better oxidizer than oxygen.
34. \_\_\_\_\_ Oxygen is heavier than air.
35. \_\_\_\_\_ Manganese dioxide was used as a catalyst in the preparation of oxygen.

Key to Work Sheet No. II

Hydrogen and Oxygen

1. Priestley
2. "Phlogiston"
3. Lavoisier

4. (a)  $2 \text{Hg} + \text{O}_2 \longrightarrow 2 \text{HgO}$   
 (b)  $2 \text{HgO} \xrightarrow{\quad} 2 \text{Hg} + \text{O}_2 \uparrow$
5.  $2\text{KClO}_3 \xrightarrow[\text{MnO}_2]{\quad} 2 \text{KCl} + 3\text{O}_2 \uparrow$
6. Catalyst
7. (a) Electrolysis of water  
 (b) Distillation of liquid air
8. (a) Odorless  
 (b) Colorless  
 (c) Tasteless
9. Oxidation
10. (a)  $2 \text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO}$   
 (b)  $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2 \uparrow$   
 (c)  $4\text{P} + 5\text{O}_2 \longrightarrow 2\text{P}_2\text{O}_5$
11. Kindling temperature
12. 3
13. (a) Increasing fineness  
 (b) More oxygen  
 (c) Higher temperature
14. (a) Combustible substance  
 (b) Oxygen  
 (c) Kindling temperature
15. Oxidation of food  
 Welding
16. Cavendish
17. (a)  $\text{Na} + \text{H}_2\text{O} \longrightarrow \text{NaOH} + \text{H}_2 \uparrow$   
 (b)  $4\text{H}_2\text{O} + 3\text{Fe} \longrightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2 \uparrow$   
 (c)  $\text{Zn} + \text{H}_2\text{SO}_4 \xrightarrow[\text{CuSO}_4]{\quad} \text{ZnSO}_4 + \text{H}_2 \uparrow$

- |                               |        |       |
|-------------------------------|--------|-------|
| 18. Copper sulfate            |        |       |
| 19. (a) Electrolysis of water |        |       |
| (b) Bosch method              |        |       |
| 20. Water                     |        |       |
| 21. Reduction                 |        |       |
| 22. Hydrogenation             |        |       |
| 23. 0                         | 27. 0  | 31. + |
| 24. +                         | 28. 0  | 32. 0 |
| 25. +                         | 29. -+ | 33. + |
| 26. 0                         | 30. +  | 34. + |
|                               |        | 35. + |

### Study Guide No. III

#### Water

1. Discussion of the uses of water around the home
2. Explanation of the uses of the eudiometer
3. Explanation of the ratio of oxygen and hydrogen in water
4. Explanation of the Law of Multiple Proportions
5. Discussion of the uses of hydrogen peroxide
6. Discussion of the physical properties of water
7. Definition of the terms density, calorie, specific gravity, specific heat, heat of vaporization, heat of fusion
8. Discussion of the chemical properties of water
9. Explanation of the terms water of crystallization, efflorescent, deliquescent, basic anhydride, acid anhydride
10. Discussion of the purification of water
11. Discussion of the characteristics of good water for community use
12. Discussion of some of the most common impurities frequently found

in drinking water

13. Discussion of local water purification
14. Discussion of preparation of chemically pure water
15. Discussion of purification of salt water for drinking purposes

#### References

- Rawlins and Struble, Chemistry in Action, pp. 78-95.
- Poster, The Romance of Chemistry, pp. 99-103.
- Holmes, Out of the Test Tube, pp. 79-89.
- Carlton and Carpenter, Chemistry for the New Age, pp. 326-341.
- McPherson-Henderson-Fowler, Chemistry at Work, pp. 114-136.

#### Subject Matter No. III

#### Water

- I. Composition of water
  - A. By volume - use of the endiometer
  - B. By weight - reduction of copper oxide
  - C. Law of Multiple Proportions
- II. Properties of Water
  - A. Physical
    1. Boiling point
    2. Caloris
    3. Specific heat
    4. Density
    5. Specific gravity
    6. Heat of vaporization
    7. Heat of fusion
  - B. Chemical
    1. Necessity for chemical reactions

2. Water of crystallization
3. Efflorescent
4. Deliquescent
5. Basic anhydride
6. Acid Anhydride

### III. Purification of water

#### A. Drinking water

1. Characteristics of good water
2. Impurities of river water
  - a. Chemicals
  - b. Suspensions
3. Treatment of
  - a. Removal of suspensions
  - b. Removal of bacteria

#### B. Chemical pure water

1. Composition of
2. Method
  - a. Distillation
  - b. Fractional distillation

#### C. Salt water

### Activities No. III

#### Water

1. Field trip to the local water purification plant
2. An experiment showing the bleaching property of hydrogen peroxide
3. An experiment to show the purification drinking water by sedimentation and filtration
4. Discussion of the meaning of new terms in the subject matter

5. An experiment on distillation
6. An experiment on the composition of water by weight

Correlations No. III

Water

I. English:

- A. Reports on the field trip to local water purification plant
- B. Program on water purification

II. Writing:

- A. Writing up experiments
- B. Writing of reports and programs

III. Art - Drawing of laboratory setup & equipment for experiments

IV. Spelling - New terms: electrolysis, density, efflorescent, anhydride, deliquescent, distillation

V. Mathematics - Figuring composition of water by weight

VI. Reading:

- A. Specific references
- B. Laboratory manuals for experiments

Work Sheet No. III

Water

Complete the following with the correct word or phrase to make them read correctly.

1. Water is composed of the two elements \_\_\_\_\_ and \_\_\_\_\_.
2. In passing hydrogen over hot copper oxide it is reduced to \_\_\_\_\_ and \_\_\_\_\_ is produced.
3. The \_\_\_\_\_ is an instrument used in determining the composition of water by combining its two elements.
4. By volume water is composed of twice as much \_\_\_\_\_ as there is

oxygen.

5. \_\_\_\_\_ is a chemical that has the formula  $H_2 O_2$ .
6. The boiling point of water is \_\_\_\_\_ degrees on the Fahrenheit thermometer and \_\_\_\_\_ degrees on the centigrade thermometer.
7. The \_\_\_\_\_ is the amount of heat required to raise the temperature of one grain of water one degree centigrade.
8. The \_\_\_\_\_ of a substance is its weight per unit volume.
9. The heat of \_\_\_\_\_ is the amount of heat required to change one gram of water at  $100^{\circ} C$ . to steam at  $100^{\circ} C$ .
10. The heat of \_\_\_\_\_ is the amount of heat required to change one gram of solid to one gram of liquid at the same temperature.
11. Water combined with a substance in its crystal form is known as water of \_\_\_\_\_.
12. Those solids that lose water on exposure to air are known as \_\_\_\_\_ substances.
13. Those solids that take on water when exposed to the air are known as \_\_\_\_\_ substances.
14. Any metallic oxide that dissolves in water to form a base is called a \_\_\_\_\_ anhydride.
15. Any non-metallic oxide that dissolves in water to form an acid is called a \_\_\_\_\_ anhydride.
16. Very fine silt is removed from drinking water by the use of \_\_\_\_\_ and \_\_\_\_\_, two chemicals that form a precipitate.
17. The large particles of silt are removed from drinking water by \_\_\_\_\_.
18. The chemical \_\_\_\_\_ is used to remove disease organisms from the water.
19. Activated \_\_\_\_\_ is sometimes used to remove odors, colors



flavors from water.

20. The chemical \_\_\_\_\_ is used to remove green algae from water held in reservoirs.
21. Chemically pure water is obtained by the process of \_\_\_\_\_.
22. The process of separating one volatile liquid from another by heat is called \_\_\_\_\_.
23. The process of changing liquid water into steam is called \_\_\_\_\_.

Mark the following statements true or false as each reads using the plus (+) sign for true and the zero (0) for false.

24. \_\_\_\_\_ Salt water cannot be made safe for drinking except by distilling.
25. \_\_\_\_\_ Ozone may be used to purify water for drinking purposes.
26. \_\_\_\_\_ The presence of calcium bicarbonate in water makes it permanently hard.
27. \_\_\_\_\_ Fine particles of silt not removed by other methods may be removed by filtration.
28. \_\_\_\_\_ Clear water is always safe for drinking purposes.
29. \_\_\_\_\_ Good drinking water must be free from all bacteria.
30. \_\_\_\_\_ Water is a stable compound but may be decomposed at very high temperatures.

#### Key to Work Sheet No. III

##### Water

- |                      |                     |
|----------------------|---------------------|
| 1. Hydrogen, oxygen  | 7. Calorie          |
| 2. Copper, water     | 8. Density          |
| 3. Endiometer        | 9. Vaporization     |
| 4. Hydrogen          | 10. Fusion          |
| 5. Hydrogen peroxide | 11. Crystallization |
| 6. 212, 100          | 12. Efflorescent    |

- |                           |                             |
|---------------------------|-----------------------------|
| 13. Deliquescent          | 22. Fractional distillation |
| 14. Basic                 | 23. Evaporation             |
| 15. Acid                  | 24. 0                       |
| 16. Aluminum sulfate lime | 25. +                       |
| 17. Sedimentation         | 26. 0                       |
| 18. Chlorine              | 27. +                       |
| 19. Carbon                | 28. 0                       |
| 20. Copper sulfate        | 29. 0                       |
| 21. Distillation          | 30. +                       |

#### Study Guide No. IV

##### Air - Mixture

1. Discussion of air as a mixture
2. Discussion of air conditioning
3. Explanation of liquidification of air
4. Discussion of some of the properties of liquid air
5. Discussion of the rare gases in the air
6. Discussion of the uses of these rare gases
7. Discussion of the seven most abundant gases in the air

##### References

- Rawlins and Struble, Chemistry in Action, pp. 97-102.
- Holmes, Out of the Test Tube, pp. 159-167.
- Jaffe, New World of Chemistry, pp. 97-109.
- McPherson and Henderson, Chemistry at Work, pp. 276-285.

#### Subject Matter No. IV

##### Air - A Mixture

- I. Composition of air
  - A. Principle gases

B. Rare gases

1. Names
2. Uses of

II. Air conditioning

A. Temperature

B. Humidity

1. Relative humidity
2. Methods of control

C. Hydrometers

D. Filtration

1. Methods
2. Reasons for

E. Fresh air

III. Liquid air

- A. Method of liquifying
- B. Properties of

Activities No. IV

Air - A Mixture

- A. Preparation of a list of the most abundant gases in the air
- B. Preparation of a list of the rare gases in the air and their uses

Correlations No. IV

Air - A Mixture

- A. Reading - Specific references
- B. Writing - Listing the gases found in air

Work Sheet No. IV

Air - A Mixture

Mark the following statements true or false as they read, using the plus (+)

sign for true and the zero (0) for false.

1. \_\_\_\_\_ The water that is found on the outside of a glass of ice water has come from the air.
2. \_\_\_\_\_ Frost on a window pane on a cold morning indicates that air contains moisture.
3. \_\_\_\_\_ Lime water becomes milky when exposed to the air. This indicates that the air contains nitrogen.
4. \_\_\_\_\_ Air may be separated into its component parts by fractional distillation of liquid air.
5. \_\_\_\_\_ The gases that make up the air are chemically combined.
6. \_\_\_\_\_ All the substances found in the air are colorless gases.
7. \_\_\_\_\_ In "air conditioning" air the same air can be used over and over without adding new air.
8. \_\_\_\_\_ We may liquify air by increasing the pressure on the gas.
9. \_\_\_\_\_ The critical temperature of a gas is the temperature at which a gas liquifies while under pressure.
10. \_\_\_\_\_ The temperature of liquid air is about the same as that of ice.
11. \_\_\_\_\_ Liquid air is stored in a tightly sealed container to prevent its evaporation.
12. \_\_\_\_\_ Helium is used in dirigibles because it is much lighter than hydrogen.
13. \_\_\_\_\_ The gas argon is used in making light bulbs because it will not burn.
14. \_\_\_\_\_ Neon is frequently used in making advertising signs.
15. \_\_\_\_\_ Hydrogen is not safe to use in dirigibles because it burns with an explosive force.

Complete the following statements to make them read correctly.

16. The air is composed of 78% \_\_\_\_\_ and 21% \_\_\_\_\_.

17. Three inert gases found in the air are a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
18. Air may be liquified by increasing the \_\_\_\_\_ and decreasing the \_\_\_\_\_ of the gas.
19. To properly "air condition" air five things must be done to it. They are: a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_, d. \_\_\_\_\_, e. \_\_\_\_\_.
20. \_\_\_\_\_ and mercury are used in the new fluorescent bulbs.

## Key to Work Sheet No. IV

## Air - A Mixture

- |      |       |       |
|------|-------|-------|
| 1. + | 6. 0  | 11. 0 |
| 2. + | 7. 0  | 12. 0 |
| 3. 0 | 8. 0  | 13. + |
| 4. + | 9. +  | 14. + |
| 5. 0 | 10. 0 | 15. + |
16. Nitrogen, oxygen
17. Neon, xenon, argon, helium, krypton
18. Pressure, temperature
19. Correct its temperature  
Correct its humidity  
Clean  
Add fresh air  
Circulate the air
20. Argon

### Culminating Activities

#### A Chemical View of Matter

- I. An exhibit of all the elements possible in the body
- II. Preparation of a class program on water purification
  - A. Selecting the parts for the students
  - B. Setting up a display of the methods of purification
  - C. Letters inviting the principal and the parents to program
- III. Preparation by students of an experiment on the reduction of copper oxide by hydrogen
- IV. Preparation by students of an experiment on weight composition of water

### Desirable Outcomes

#### A Chemical View of Matter

- I. Knowledge and Understanding of:
  - A. Characteristics of matter
    1. Analysis - determining the composition of a substance
    2. Elements
      - a. Atoms
        - (1) Same number of protons
        - (2) Destruction by chemical means impossible
      - b. 96 known elements
      - c. Naming of by discoverer
      - d. "Um" and "ium" ending of recent metals
      - e. Different kinds
        - (1) Metals
          - (a) Shiny luster
          - (b) Conductors of heat and electricity

- (c) Drawn into wire
- (d) Rolled into sheets
- (e) Oxides in water
- (f) "um" and "ium" ending for new ones

(2) Non-metals

- (a) Opposite of metals
- (b) Formation of acids
- (c) "N" and "ne" ending of new ones

(3) Amphoteric - Possessing properties of metals and non-metals

(4) Inert - Chemically inactive

3. Compounds

- a. Consisting of two or more elements
- b. Elements in definite proportions by weight
- c. Dalton's atomic theory

(1) Composition of matter by atoms

(2) Atoms of elements

- (a) Alike in size and weight
- (b) Same number of protons

(3) Atoms of compounds

- (a) Two or more different atoms
- (b) In definite proportion by weight

(4) Molecules

- (a) Composed of atoms
- (b) Held together by chemical affinity

d. Dalton's Law or Law of Definite proportions -

Every compound - A definite composition by weight

e. Symbols

- (1) Represents name of element
- (2) Represents one atom of elements
- (3) Represents weight of one atom

f. Formulas

- (1) Indicates the elements in a compound
- (2) Indicates number of atoms of each element
- (3) Molecular weight - Sum of atomic weights
- (4)  $H_2O$ 
  - (a) Contains two hydrogen atoms
  - (b) Contains one oxygen atom
  - (c) One molecule

4. Mixture

- a. Not chemically combined
- b. Not in definite proportions
- c. Separated by mechanical means
- d. Mixed in any proportion

5. Changes of matter

a. Physical change

- (1) Composition of matter same
- (2) Change in color, size, shape
- (3) Examples
  - (a) Tearing of paper
  - (b) Dissolving of sugar
  - (c) Melting of ice
- (4) Dispersion - Even disbursement of solid molecules in liquid molecules



- (5) Sublimation - Solid to vapor to solid
- (6) Fusion - Changing of solid into liquid
- (7) Evaporation- Changing of liquid into gas

b. Chemical change

- (1) Resulting in new material
- (2) Resulting in new properties
- (3) Examples
  - (a) Burning of paper
  - (b) Digestion of food
  - (c) Rusting of iron
- (4) Production of energy or exchanging of energy
- (5) Forms of energy
  - (a) Heat
  - (b) Light
  - (c) Electrical

c. Types of chemical reactions

(1) Combination or synthesis

(a) Word equation - Zinc + sulfur  $\xrightarrow{\text{heat}}$  zinc sulfide

(b) Symbols and formula



(2) Decomposition or analysis

(a) Breaking down of a compound

(b) Word equation - Mercuric oxide  $\xrightarrow{\text{heat}}$  mercury + oxygen

(c) Formula or symbol equation



(d) Qualitative analysis - Determination of amounts  
of each element in compound

## (3) Single replacements or substitution

(a) Replacing one element for another

(b) Word equation - Copper + silver nitrate  $\longrightarrow$  copper nitrate + silver

(c) Symbol or formula equation



## (4) Double replacement

(a) Word equation - Barium chloride + sodium

sulfate  $\longrightarrow$  barium sulfate + sodium chloride

(b) Symbol or word equation



## (5) Polymerization

(a) Association of two or more of the same molecule

(b) Producing complex molecule

## B. Two common elements

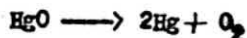
## 1. Oxygen

a. Discovered by Priestly

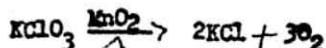
b. Named by Lavoisier

c. Preparation

(1) Heating of mercuric oxide



(2) Heating of potassium chlorate

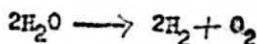


d. Manganese dioxide - A catalyst

e. Catalyst - Unchanged by reaction

f. Commercial preparation

(1) Electrolysis of water



- (2) Fractional distillation of air
- g. Present in almost every substance
- h. Physical properties
  - (1) Colorless, tasteless, odorless
  - (2) Slightly soluble in water
  - (3) Heavier than air
- i. Chemical properties
  - (1) Supporter of combustion
  - (2) Oxidation - Combining of oxygen with any other substance
  - (3) Equation -  $2Mg + O_2 \longrightarrow 2MgO$
  - (4) Kindling temperature - Starting point of burning
- j. Ozone
  - (1) Composition of three oxygen atoms
  - (2) Good oxidising agent
  - (3) Produced during lightning
  - (4) Useful as a bleaching agent, deodorant, drier of paint
- k. Oxidation
  - (1) Increased by
    - (a) Increasing amount of oxygen
    - (b) Powdering substance
    - (c) Presence of water
    - (d) Increase in chemical activity of substance
  - (2) Decreased by
    - (a) Painting
    - (b) Use of oil or grease
  - (3) Prevention of
    - (a) Removing combustible substance

(b) Stopping supply of oxygen

(c) Lowering temperature

(4) Fires

(a) Carelessness frequent causes

(b) Caused by spontaneous combustion

1. Uses

(1) Oxidation of food in body

(2) Treating diseases

(3) Welding

2 Hydrogen

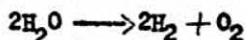
a. Discovered by Cavendish

b. Found in water, fuels, foods, textiles

c. Preparation of

(1) Laboratory

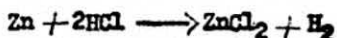
(a) Electrolysis of water



(b) Action of sodium on water



(c) Acid upon metal



(d) Catalyst - Copper sulfate

(2) Commercial

(a) Electrolysis of water

(b) Bosch process - Steam over hot coke

d. Electromotive series of metals

(1) Replacing of hydrogen by metal

(2) Capable if above hydrogen

(3) Not capable if below hydrogen

## e. Properties

## (1) Physical

- (a) Colorless, odorless, tasteless
- (b) Soluble in water
- (c) Lightest gas
- (d) Diatomic

## (2) Chemical

- (a) Burns forming water
- (b) Explosive with oxygen
- (c) A reducing agent

## f. Uses

- (1) As a reducing agent
- (2) Filling of dirigibles, blimps
- (3) Hydrogenation of oils
- (4) Cutting of steel

## C. Water

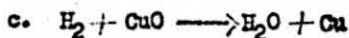
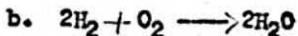
## 1. Very stable

## 2. Composed of hydrogen and oxygen

## 3. Hydrogen and oxygen in ratio 2 to 1 by volume

## 4. Hydrogen and oxygen in ratio of 1 to 8 by weight

## 5. Equations



## 6. Properties

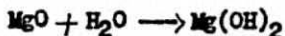
## a. Physical

- (1) Colorless, odorless, tasteless liquid

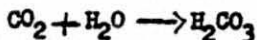
- (2) 100° C or 212° F boiling temperature
- (3) 32° F or 0° C freezing temperature
- (4) Universal solvent

b. Chemical

- (1) Catalyst in chemical reactions
- (2) Combines with compounds to form crystals
- (3) Forms bases with metallic oxides



- (4) Forms acids with non-metallic oxides



7. Calorie

- a. Measurement of heat
- b. One gram of water one degree C

8. Specific heat

- a. Based on water
- b. Ratio of heat per gram per degree

9. Density

- a. Weight per unit volume
- b. Expressed as grams per unit volume

10. Specific gravity

- a. Based upon water density
- b. Ratio of density of substance and water

11. Heat of vaporization - Quantity of heat for changing unit mass of solid into vapor at same temperature

12. Heat of fusion - Quantity of heat for changing unit mass of solid into liquid at same temperature

13. Water of crystallization

- a. Chemically combined water
- b. Expressed as  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
- 14. Efflorescent substance - Giving off water
- 15. Deliquescent substance - Absorbing of water
- 16. Basic anhydride
  - a. Metallic oxide
  - b. Forming of base with water
- 17. Acid anhydride
  - a. Non-metallic oxide
  - b. Forming acid with water
- 18. Processes of water purification
  - a. Removing of silt by sedimentation
  - b. Using of alum and lime in removing silt
  - c. Using of filters in removing silt
  - d. Using of chlorine in killing disease germs
  - e. Using of copper sulfate in preventing algae growths
  - f. Using of charcoal in removing color, taste, odor
- 19. Characteristics of good drinking water
  - a. Free from disease germs
  - b. Clear, sparkling, colorless
  - c. Good tasting, odorless, cool
  - d. Reasonably "soft"
  - e. Produce no scales or corrosion
  - f. Free from harmful chemicals
  - g. Plentiful and cheap
- 20. Emergency purifying methods
  - a. Boiling

- b. Use of iodine
- c. Use of Halogone tablets
- 21. Chemically pure water
  - a. Obtained by distillation
  - b. Free from all other substances
  - c. Used in scientific work
- D. Air - A typical mixture
  - 1. Composed of several gases
  - 2. Seperable into component parts by fractional distillation
  - 3. Broken down by mechanical means
  - 4. Principally nitrogen and oxygen
  - 5. Easily liquified by pressure
  - 6. Air conditioned by
    - a. Correcting temperature
    - b. Correcting humidity
    - c. Removing all dust, bacteria, etc.
    - d. Adding fresh air at all times
    - e. Putting in circulation
  - 7. Rare and inert gases
    - a. Neon - Neon signs
    - b. Xenon - Neon signs
    - c. Argon - Light bulbs, fluorescent bulbs
    - d. Helium - Lighter than air craft
    - e. Krypton - Neon signs

## II. Attitude toward:

- A. Increasing our knowledge through study
- B. Increasing our progress through study



- C. Bettering our study habits
- D. Classifying matter for increased learning
- E. The work of chemist in classifying matter
- F. Classifying matter as an aid in studying all elements
- G. Determining why events happen
- H. Work of chemist in improving our daily lives
- I. Explaining the process of rusting, burning by chemical means
- J. Benefits of studying oxygen
- K. Purification of water and its benefits
- L. Nature of air and formation of rain, frost, dew, etc.

III. Habit of:

- A. Using the knowledge gained in studying this unit
- B. Explaining natural phenomena in chemical terms
- C. Verifying certain phenomena by experimentation
- D. Refraining from criticizing the chemist when water taste "bad"
- E. Writing equations in terms of symbols and formulas
- F. Using symbols and formulas for substances
- G. Studying each study guide

IV. Appreciation for:

- A. Contributions of the chemist
- B. Classification of matter
- C. The study of oxygen
- D. The study of hydrogen
- E. The study of air
- F. Water and its importance to man
- G. Water purification
- H. Prevention of rusting or oxidation

- I. Explanation of burning
- J. Good study habits
- K. Good laboratory work

#### Leads to Other Units

#### A Chemical View of Matter

The student should have gained much information in studying this unit that will help him to understand the following units:

- III. The Structure of Matter
- IV. Theory of Solutions
- V. Nitrogen and Its Compounds
- VI. The Wonder Element Carbon
- VII. The Periodic Law and Chemical Families
- VIII. Some Important Non-Metals
- IX. The Metals

#### Teacher Evaluation

#### A Chemical View of Matter

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free informal associations of pupils?
3. Provide an opportunity for manipulative activity?
4. Make a coherent whole?
5. Provide a considerable amount of student activity?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
✓					
	✓				
✓					

	Ex.	V.G.	G	F	P	None
6. Produce satisfying outcomes?			✓			
7. Provide sufficient concrete and illustrative material?		✓				
8. Have a useful purpose in the present and future life of pupils?			✓			
9. Reproduce actual life situations as far as possible?			✓			
10. Utilize materials as they occur in life?			✓			
11. Contain some accurate materials?	✓					
12. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?			✓			
13. Provide opportunity to judge, choose, and evaluate?		✓				
14. End of lies within available time?	✓					
15. Make it possible for a new teacher to put in practice if she desires?		✓				
16. State clearly where materials may be obtained?	✓					
17. Give complete exact references?	✓					

## Pupil Test

## Knowledge Test

## A Chemical View of Matter

Complete the following statements with the correct word or phrase to make them read correctly.

1. An \_\_\_\_\_ is a simple substance which cannot be broken up into any simpler substance by ordinary chemical means.
2. There are \_\_\_\_\_ known elements.
3. \_\_\_\_\_ elements are those that exhibit properties of both metals and non-metals.
4. A \_\_\_\_\_ is a substance composed of two or more elements combined in a definite ratio.
5. The components of a mixture may be separated by (chemical, physical) \_\_\_\_\_ means.
6. A compound (will, will not) \_\_\_\_\_ always resemble the elements that compose it.
7. Iron filings may be removed from a sulfur-iron mixture by means of a \_\_\_\_\_.
8. A sign or letter used to designate an element is called a \_\_\_\_\_.
9. When two or more symbols are put together to represent a compound they are called a \_\_\_\_\_.
10. A \_\_\_\_\_ change occurs when a new product is produced during a chemical reaction.
11. The changing of water into steam is an example of a \_\_\_\_\_ change.
12. A compound is the result of a \_\_\_\_\_ change.
13. The combining of oxygen and iron is an example of a \_\_\_\_\_ reaction.

14. The heating of mercuric oxide in the laboratory represents a \_\_\_\_\_ reaction.
15. \_\_\_\_\_ is the changing of a solid into a liquid.
16. Up until the discovery of oxygen burning was explained by the \_\_\_\_\_ theory.
17. The two substances \_\_\_\_\_ and \_\_\_\_\_ were used in the laboratory preparation of oxygen.
18. A substance that speeds up a reaction and yet is not altered itself is called a \_\_\_\_\_.
19. The combining of oxygen with any other substance is called \_\_\_\_\_.
20. Ozone contains \_\_\_\_\_ atoms of oxygen.
21. The three conditions necessary for burning to take place are:  
a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
22. \_\_\_\_\_ was used in the laboratory as a catalyst in the preparation of hydrogen.
23. The process of removing oxygen from oxides by hydrogen is called \_\_\_\_\_.
24. Water is composed of the two elements \_\_\_\_\_ and \_\_\_\_\_.
25. The formula  $H_2O_2$  represents the compound \_\_\_\_\_.
26. The \_\_\_\_\_ is the amount of heat required to raise the temperature of one gram of  $H_2O$  one degree centigrade.
27. Water combined with a substance in its crystal form is known as water of \_\_\_\_\_.
28. Those solids that lose water on exposure to air are known as \_\_\_\_\_ substances.
29. Any metallic oxide that dissolves in water to form a base is called a anhydride.

30. The large particles of silt in water are removed by \_\_\_\_\_.
31. The chemical \_\_\_\_\_ is used to kill disease germs in drinking water.
32. The chemical \_\_\_\_\_ is used to kill green algae that grows in water stored in reservoirs.
33. Chemically pure water is obtained by the process of \_\_\_\_\_.
34. The process of changing a liquid water into water vapor is called \_\_\_\_\_.
35. The air is composed of \_\_\_\_\_% nitrogen and \_\_\_\_\_% oxygen.
36. Three inert gases found in the air are a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
37. Complete and balance the following equations:
- $\text{Hg} + \text{O}_2 \longrightarrow$
  - $\text{KClO}_3 + \text{MnO}_2 \longrightarrow$
  - $\text{CuO} + \text{H}_2 \longrightarrow$
  - $\text{Zn} + \text{H}_2\text{SO}_4 \xrightarrow{\text{CuSO}_4}$
  - $\text{AgNO}_3 + \text{Cu} \longrightarrow$

Mark the following statements true or false using the plus (+) for true and zero (0) for false.

- \_\_\_\_\_ 1. The gases that make up air are chemically combined.
- \_\_\_\_\_ 2. The gas helium is used in lighter-than-air craft because it will not burn.
- \_\_\_\_\_ 3. Neon lights are filled with the inert gas argon.
- \_\_\_\_\_ 4. Ozone is a better oxidizing agent than oxygen.
- \_\_\_\_\_ 5. All bacteria must be removed from drinking water to make it safe.
- \_\_\_\_\_ 6. Hard water may be made soft by the use of various chemicals.
- \_\_\_\_\_ 7. All living organisms must have oxygen in order to live.
- \_\_\_\_\_ 8. Water is a mixture of the two elements hydrogen and oxygen.

Key to Knowledge Test  
A Chemical View of Matter

Completion

- |                        |                                   |
|------------------------|-----------------------------------|
| 1. Element             | 20. Three                         |
| 2. 96                  | 21. (a) Have a fuel               |
| 3. Amphoteric          | (b) Supply of oxygen              |
| 4. Compound            | (c) Heat                          |
| 5. Physical            | 22. Copper sulfate                |
| 6. Will not            | 23. Reduction                     |
| 7. Magnet              | 24. Hydrogen and oxygen           |
| 8. Symbol              | 25. Hydrogen peroxide             |
| 9. Formula             | 26. Caloric                       |
| 10. Chemical           | 27. Crystallization               |
| 11. Physical           | 28. Deliquescent                  |
| 12. Chemical           | 29. Anhydride                     |
| 13. Combination        | 30. Filtration or sedimentation   |
| 14. Decomposition      | 31. Chlorine                      |
| 15. Fusion             | 32. Copper sulfate                |
| 16. Phlogiston         | 33. Distillation                  |
| 17. Potassium chlorate | 34. Evaporation                   |
| Manganese dioxide      | 35. 78, 20                        |
| 18. Catalyst           | 36. Helium, neon, argon, krypton, |
| 19. Oxidation          | krypton                           |

37. a.  $2\text{HgO} \xrightarrow{\quad} 2\text{Hg} + \text{O}_2$   
 b.  $2\text{KClO}_3 \xrightarrow{\text{MnO}_2} 2\text{KCl} + 3\text{O}_2$   
 c.  $\text{CuO} + \text{H}_2 \xrightarrow{\quad} \text{Cu} + \text{H}_2\text{O}$   
 d.  $\text{Zn} + \text{H}_2\text{SO}_4 \xrightarrow{\text{CuSO}_4} \text{ZnSO}_4 + \text{H}_2$   
 e.  $\text{AgNO}_3 + \text{Cu} \longrightarrow \text{Cu(NO}_3)_2 + \text{Ag}$

## True and false

- |      |      |
|------|------|
| 1. + | 5. 0 |
| 2. + | 6. + |
| 3. 0 | 7. + |
| 4. + | 8. 0 |

## Pupil Test

## Attitude Test

## A Chemical View of Matter

Answer the following questions by placing a yes or no before each one.

- \_\_\_\_\_ 1. Through studying do you gain more knowledge than through actual experience?
- \_\_\_\_\_ 2. Does studying help you to carry out your experiments at a faster rate?
- \_\_\_\_\_ 3. Does being orderly in your work help you obtain better experimental results in the laboratory?
- \_\_\_\_\_ 4. Does an understanding of the elements classification help you in studying them? |
- \_\_\_\_\_ 5. Does an understanding of the nature of mixtures help you to understand water purification?
- \_\_\_\_\_ 6. Does an understanding of the nature of compounds help you to understand why water is always chemically the same at any place?
- \_\_\_\_\_ 7. Does a study of the properties of certain elements help you in classifying them?
- \_\_\_\_\_ 8. Is it easier for you to use symbols for the elements rather than the name?
- \_\_\_\_\_ 9. Does a formula for a compound tell you more than the name of the compound?



- \_\_\_\_\_ 10. Does writing a formula equation for a reaction tell you more than the word equation?
- \_\_\_\_\_ 11. Does a knowledge of chemical changes help you understand how ripe fruits taste better than unripe ones?
- \_\_\_\_\_ 12. Does a knowledge of chemical changes help you to understand how oxygen is obtained from its compounds?
- \_\_\_\_\_ 13. Does the chemical change help you to understand why burning sugar is offensive?
- \_\_\_\_\_ 14. Does a knowledge of oxygen help you to understand its importance to life?
- \_\_\_\_\_ 15. Does a knowledge of oxygen help you to understand why it is used in welding?
- \_\_\_\_\_ 16. Does a knowledge of hydrogen help you to understand why it is dangerous?
- \_\_\_\_\_ 17. Does a knowledge of oxygen help you to understand why a fire burns better when a wind is present?
- \_\_\_\_\_ 18. Does a knowledge of oxygen help you to understand why metal things are painted?
- \_\_\_\_\_ 19. Does the study of water purification help you understand why it is such an expensive process?
- \_\_\_\_\_ 20. Does a knowledge of water purification help you understand why the city needs a chemist?
- \_\_\_\_\_ 21. Does a knowledge of water purification help you to explain why the water tastes different at different times?
- \_\_\_\_\_ 22. Does a knowledge of the composition of air help you to understand why we can not live without it?
- \_\_\_\_\_ 23. Does a knowledge of the inert gases help you to understand why

they are used in light bulbs?

- \_\_\_\_\_ 24. Does a knowledge of the characteristics of helium help you to understand its use in dirigibles and balloons?
- \_\_\_\_\_ 25. Does a study of the air help you to understand how different colored neon signs are made?

#### Pupil Test

#### Habit Test

#### A Chemical View of Matter

Mark the following statements according to the way you do them. If you do them place a plus (+) in front, if you don't place a zero (0) in front of each.

- \_\_\_\_\_ 1. Do you use your study guides every day in your studying?
- \_\_\_\_\_ 2. Do you study every experiment before attempting to do it?
- \_\_\_\_\_ 3. Do you complete every experiment?
- \_\_\_\_\_ 4. Do you use the chemical formula for compounds instead of the word name?
- \_\_\_\_\_ 5. Do you use the chemical symbol for the elements instead of the word name?
- \_\_\_\_\_ 6. Do you use the formula equation for a chemical equation instead of the word equation?
- \_\_\_\_\_ 7. Do you use the knowledge of oxygen in explaining why metals rust?
- \_\_\_\_\_ 8. Do you use the knowledge of the nature of oxygen to explain why painting is necessary?
- \_\_\_\_\_ 9. Do you use the knowledge of the nature of water to explain why wet wood rots?
- \_\_\_\_\_ 10. Do you use the knowledge of the nature of air to explain why the fire in a stove goes out when the draft is shut?

- \_\_\_\_\_ 11. Do you adjust your Bunsen burner to get the desired amount of air?
- \_\_\_\_\_ 12. Do you generate hydrogen in the presence of a flame?
- \_\_\_\_\_ 13. Do you explain why oxygen tents are used in respiratory diseases in light of the nature of air?
- \_\_\_\_\_ 14. Do you blame the city chemist when the drinking water tastes bad on certain days?
- \_\_\_\_\_ 15. Do you explain why the drinking water tastes bad in light of the chemicals used in its purification?

Key to Habit Test

A Chemical View of Matter

The correct answer to all questions is yes

Pupil Test

Appreciation Test

A Chemical View of Matter

Answer the following with a yes or no before each statement.

- \_\_\_\_\_ 1. Do you appreciate the work done by chemist in classifying matter?
- \_\_\_\_\_ 2. Do you appreciate the advantages of a classification system?
- \_\_\_\_\_ 3. Do you appreciate general information gained by classifying the elements?
- \_\_\_\_\_ 4. Do you appreciate the classification of substances as compounds, mixtures, and elements?
- \_\_\_\_\_ 5. Do you appreciate the principles of Dalton's Law concerning matter?
- \_\_\_\_\_ 6. Do you appreciate the use of symbols in chemical work?
- \_\_\_\_\_ 7. Do you appreciate the use of formulas in writing the names of substances?

- \_\_\_\_\_ 8. Do you appreciate the knowledge of chemical changes and their place in chemistry?
- \_\_\_\_\_ 9. Do you appreciate the practical uses made of the physical changes of matter?
- \_\_\_\_\_ 10. Do you appreciate the use of formulas in writing chemical reactions?
- \_\_\_\_\_ 11. Do you appreciate the practical uses made of the chemical changes in matter?
- \_\_\_\_\_ 12. Do you appreciate the use of the chemist of the chemical behavior of the elements and compounds?
- \_\_\_\_\_ 13. Do you appreciate the knowledge of chemical properties of oxygen and its uses in life?
- \_\_\_\_\_ 14. Do you appreciate the knowledge of oxygen and its practical application?
- \_\_\_\_\_ 15. Do you appreciate the study of oxygen and its explanation of burning?
- \_\_\_\_\_ 16. Do you appreciate the study of hydrogen and its contributions to life?
- \_\_\_\_\_ 17. Do you appreciate the opportunity to study oxygen and hydrogen in the laboratory?
- \_\_\_\_\_ 18. Do you appreciate the study of water and its importance to life?
- \_\_\_\_\_ 19. Do you appreciate the study of water purification and its contribution to health?
- \_\_\_\_\_ 20. Do you appreciate the use of chemistry in making pure drinking water?
- \_\_\_\_\_ 21. Do you appreciate the importance of water to chemistry?
- \_\_\_\_\_ 22. Do you appreciate the use of chemistry in sewage purification?

- \_\_\_\_\_ 23. Do you appreciate the study of air and its importance to life?
- \_\_\_\_\_ 24. Do you appreciate the use of the inert gases in the making of neon gases?
- \_\_\_\_\_ 25. Do you appreciate the use of helium in lighter-than-air craft?

#### Key to Appreciation Test

#### A Chemical View of Matter

A desirable answer to all the questions is yes

#### Bibliography

#### A Chemical View of Matter

##### Teacher

Rawlins - Struble, Chemistry in Action, (D. C. Heath and Company, Boston, Mass., 1948).

Harap, Western Reserve Bulletin, No. 17.

Jones - Grizzell - Grenstead, Principles of Unit Construction, (McGraw-Hill Book Co., Inc., New York, 1939).

Spears, Harold, The Emerging High School Curriculum, (American Book Co., Chicago, Ill., 1940).

Foster, William, Romance of Chemistry, (Rand McNally and Company, Chicago, Ill., 1936).

Holmes, Harry N., Out of the Test Tube, (Emerson Books, Inc., New York, 1943).

##### Pupil

Rawlins - Struble, Chemistry in Action, (D. C. Heath and Co., Boston, Mass., 1948).

Foster, William, Romance of Chemistry, (Rand McNally and Co., Chicago, Ill., 1936).

Holmes, Harry N., Out of the Test Tube, (Emerson Books, Inc., New York, 1943).

Carleton - Carpenter, Chemistry for the New Age, J. B. Lippincott Company, Chicago, Ill., 1949).

Jaffe, Bernard, The New World of Chemistry, (Silver Burdett Company, Chicago, Ill., 1949).

Biddle - Bush, Chemistry Today, (Rand McNally and Company, Chicago, Ill., 1949).

McPherson - Henderson - Fowler, Chemistry at Work, (Ginn and Company, Chicago, Ill., 1948).

### Unit No. III

#### The Structure of Matter

Man's concept of matter has changed radically since the year nineteen hundred. The discovery of radium and a study of its properties, along with experimental work with vacuum tubes, have provided information about the fundamental structure of the atom. Within the last two decades machines weighing many tons have been constructed for use in "smashing" tiny, invisible atoms which for many years were believed to be indestructable.

During World War II methods were developed for liberating the tremendous amounts of energy within the atom. The atomic bomb resulted from these discoveries. Will man be able to utilize atomic energy for constructive peacetime purposes? It has been suggested that at last energy is available for rocket ships to the moon or elsewhere. Who knows? These questions are yet unanswered, but in this unit you will find the answers to some of the questions about the structure of matter.

We know matter exists in the gaseous, liquid, and solid states, but what is matter? We shall discuss some of its fundamental properties in the problems of this unit.<sup>†</sup>

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<sup>†</sup> Rawlins and Struble, Chemistry in Action, p. 107.

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#### Criteria for Evaluation of a Unit<sup>8</sup>

##### Structure of Matter

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal associations of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil.

<sup>8</sup>

Harap, Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.

9. It should reproduce actual life situations.
10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupils to originate, plan, and direct activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - 20 days

Central Theme - An inside view of matter

#### Objectives

##### Structure of Matter

#### A. Knowledge and Understanding of:

1. The nature of molecules
2. The structure of atoms
3. Formation of compounds
4. Transmutation of elements
5. Chemical equations

#### B. Attitude toward:

1. Nature of matter and molecules
2. The properties of matter and the characteristics of its molecules
3. The Kinetic - Molecular Theory and the characteristics of matter
4. Differences of molecules

5. The atomic, molecular and relative weights
6. Atoms and the nature of these atoms
7. The study of the nature of atoms and the formation of compounds
8. The nature of atoms and the formation of compounds from the same elements
9. The use of chemical equations in chemical reactions
10. Dependence of chemistry upon the atomic and molecular theories

C. Habit of:

1. Using the characteristics of the molecule in explaining the nature of boiling, melting, diffusion, evaporation
2. Associating the characteristics of molecules with the nature of solids, liquids, and gases
3. Accounting for the differences in compounds on the basis of their molecular composition
4. Thinking of atomic and molecular weights as relative weights and their usefulness in determining the nature of chemical reactions
5. Using the atomic structure of atoms in determining some of its chemical properties
6. Using the atomic structure of atoms
7. Reading articles on the transmutation of elements
8. Writing all chemical reactions in terms of symbols and formulas in making a complete chemical equation

D. Appreciation for:

1. The Kinetic-Molecular Theory and the characteristics of matter
2. The atomic theory and the formation of compounds
3. The atomic theory and the chemical behavior of matter
4. The transmutation of elements

5. Transforming of elements and the treatment of diseases
6. The atomic energy discovery
7. Radioactivity of the elements and the treatment of diseases
8. The simplicity of the chemical equation in chemical reactions

#### Approaches

##### The Structure of Matter

In the previous topic of study we have been studying some of the ways matter has been classified. In the study we became acquainted with the nature of elements, compounds, and mixtures. Our study also included a representative of each and how they differed chemically. In our next field of study we are going to study some of the characteristics of matter that will be helpful in explaining its chemical behavior.

Perhaps you have never thought of how a liquid evaporates or a gas diffuses to all parts of a room. If you have, you should secure an answer in this study. Have you wondered about the atomic bomb and how it works? We will attempt to find the answer to some of your questions.

This unit may be effectively introduced by showing the film "Atomic Energy" which is available from Encyclopedia Britannica Films, 20 North Wacker Drive, Chicago 6, Illinois. The film "Molecular Theory of Matter" can be obtained from the same source.

#### Study Guide No. I

##### The Nature of Molecules

1. Definition of a molecule
2. Explanation of the structure of solids, gases, liquids
3. Explanation of the meaning of the diffusion of gases
4. Illustration of the diffusion of gases
5. Explanation of the effect of heat upon the motion of molecules

6. Explanation of the Kinetic-Molecular Theory in your own words
7. An illustration of Gay-Lussac's Law
8. An explanation of the formula  $N_2$  for nitrogen
9. An explanation of the formulas of hydrogen, oxygen written as  $H_2$  and  $O_2$
10. An explanation of the use of the weight of oxygen as a basis for relative atomic weights
11. Calculation of the molecular weights of  $KNO_3$  and  $MgSO_4$
12. Calculation of the percentage composition of  $NH_3$  and  $NaHCO_3$
13. Calculation of the percentage of chlorine in  $NaCl$ ,  $KClO_3$  and  $HCl$

#### References

Rawlins and Struble, Chemistry in Action, pp. 108-123.

Carleton and Carpenter, Chemistry for the New Age, pp. 143-172.

#### Subject Matter No. I

#### The Nature of Molecules

#### I. Kinetic-Molecular Theory

##### A. Evidences supporting

1. Definition of molecule
2. That gases intermingle
3. Diffusion of gases
  - a. Definition of
  - b. Bromine and air an example of
4. Diffusion in liquids
5. Space between molecules
6. Osmosis
7. Affects of heat on molecular motion
8. Boiling of liquids
  - a. Vapor pressure

b. Atmospheric pressure

9. Affect of water vapor pressure upon the volume of gases

10. Molecular motion in solids

B. Principles of

1. Molecular structure of gases and liquids

2. Elasticity and motion of molecules

3. Space between molecules

4. Collision of molecules and pressure

5. Molecular motion in liquids

6. Molecular movement in solids

7. An increase in temperature and motion

II. Composition of molecule

A. Gay-Lussac's Law

1. Experiments with

a. Hydrogen chloride

b. Water

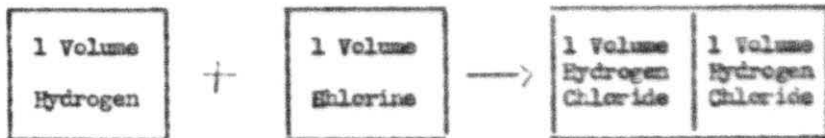
c. Ammonia

2. Principle

a. Statement of

b. Meaning of

3. Illustration



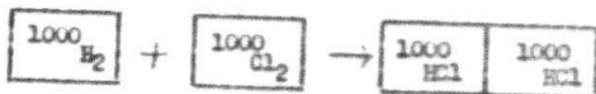
B. Avagadro's Law

1. Principle

a. Statement of

## b. Meaning of

## 2. Illustration



## III. Atomic and molecular weights

## A. Early standards of measurements

1. Rod
2. Yard
3. Measurements as relative figures
4. Atoms

## B. Oxygen as a standard

1. Combining with majority of other elements
2. Given a value of 16
3. Relationship of the weights of volume of other gases and equal volume of oxygen

## C. Determination of molecular weights

1. Avogadro's Law and gases
2. Freezing point and boiling points of dissolved solids
3. Calculations from the formula

## D. Determination of percentage composition

1. Using formula to determine molecular weight of compound
2. Using formula to determine total weight of each element

3. Dividing the weight of each element by molecular weight of compound
- E. Determination of molecular weights experimentally
  1. Volume of one gram molecular weight of a gas
  2. Determination of weight of one liter of a gas
  3. Multiplying this by 22.4
- F. Determination of molecular weight of non-volatile substances
  1. Boiling point
  2. Freezing point
- G. Determination of formulas
  1. Percentage composition by experimentation
  2. Determining the molecular weight
  3. Dividing percentage by atomic weight
  4. Determining atomic ratio
  5. Converting atomic ratio to whole numbers

#### Activities No. I

##### The Nature of Molecules

- A. An experiment illustrating the diffusion of
  1. Solid in liquid
  2. Gas in gas
- B. An experiment determining percentage of oxygen in potassium chlorate
- C. An experiment determining the equivalent and atomic weights of magnesium
- D. An experiment determining the molecular weight of oxygen

#### Correlations No. I

##### The Nature of Molecules

- A. Writing - Writing up each experiment
- B. Mathematics



1. Problems on percentage composition
2. Problems on molecular weights
3. Problems on determining formulas

C. Reading

1. Subject matter assigned
2. Specific references
3. Laboratory manuals

Work Sheet No. I

The Nature of Molecules

Complete the following with the proper word or phrase.

1. All matter is made up of very small particles called \_\_\_\_\_.
2. Substances which evaporate are said to be \_\_\_\_\_.
3. \_\_\_\_\_ is the diffusion of a substance through porous membrane from a high concentration to a low concentration.
4. The \_\_\_\_\_ temperature of a liquid is that temperature at which the vapor pressure of the liquid equals the atmospheric pressure.
5. State Gay-Lussac's Law.
6. State Avogadro's hypothesis.
7. The element \_\_\_\_\_ is now used as a standard for determining atomic and molecular weights.
8. The atomic weight of oxygen is \_\_\_\_\_.
9. What will be the molecular weight of the compound  $\text{Na Cl}$  \_\_\_\_\_?
10. What is the percentage of chlorine (Cl) in sodium chloride ( $\text{Na Cl}$ )?  
\_\_\_\_\_
11. The weight of one liter of a gas at standard conditions was found to be 0.824. What is its molecular weight? \_\_\_\_\_

12. Six grams of a substance lowered the freezing point of 1000 ml. of water  $.1^{\circ}$  C. What is its molecular weight? \_\_\_\_\_
13. Five grams of a substance raised the boiling point of 1000 ml. of water  $.5^{\circ}$  C. What is its molecular weight? \_\_\_\_\_
14. By analysis a compound was found to be 27.3 per cent carbon and 72.7 per cent oxygen. Its molecular weight is 44. What is its simplest formula? \_\_\_\_\_

Mark the following true or false using the plus (+) for true and zero (0) for false.

- \_\_\_\_\_ 1. All molecules are the same size and alike in structure.
- \_\_\_\_\_ 2. All gases are made up of molecules.
- \_\_\_\_\_ 3. The fact that air is usually a uniform mixture of gases illustrates diffusion.
- \_\_\_\_\_ 4. Bromine is non-volatile liquid.
- \_\_\_\_\_ 5. Diffusion takes place only in gases.
- \_\_\_\_\_ 6. The molecules of a gas are farther apart than those in a liquid.
- \_\_\_\_\_ 7. Molecules are in constant motion.
- \_\_\_\_\_ 8. Osmosis takes place from a low concentration to a high concentration.
- \_\_\_\_\_ 9. An addition of heat to a gas causes the molecules to move faster.
- \_\_\_\_\_ 10. Evaporation is due to the motion of the molecules.
- \_\_\_\_\_ 11. The faster the molecules move the faster a liquid evaporates.
- \_\_\_\_\_ 12. Liquids boil at a lower temperature when the pressure is increased.
- \_\_\_\_\_ 13. Water boils at  $100^{\circ}$  C. at every place on the earth's surface.
- \_\_\_\_\_ 14. A liquid will boil when the vapor pressure is equal to the atmospheric pressure.

- \_\_\_\_\_ 15. The molecules of a solid do not move.
- \_\_\_\_\_ 16. The pressure of gas is due to the motion of the molecules.
- \_\_\_\_\_ 17. Two volumes of hydrogen gas will react with oxygen to form one volume of water vapor.
- \_\_\_\_\_ 18. Gay-Lussac found that equal volumes of gases under the same conditions contains the same number of molecules.
- \_\_\_\_\_ 19. All atomic weights are now based upon hydrogen taken as one.
- \_\_\_\_\_ 20. From the formula of water the atomic weight of oxygen is found to be 32.
- \_\_\_\_\_ 21. Atomic weights are relative weights and not true weights.
- \_\_\_\_\_ 22. One molecular weight of a gas occupies 22.4 liters at standard conditions.
- \_\_\_\_\_ 23. Adding a gram-molecular weight of a solid will lower the freezing point of 1000 ml. of water  $.52^{\circ}\text{C}$ .
- \_\_\_\_\_ 24. Carbon dioxide always has the formula  $\text{CO}_2$ .
- \_\_\_\_\_ 25. Avogadro found that oxygen is always composed of two atoms of oxygen.
- \_\_\_\_\_ 26. All gases are made up of two atoms per molecule.

Key to Work Sheet No. I

The Nature of Molecules

Completions:

- |              |            |
|--------------|------------|
| 1. Molecules | 3. Osmosis |
| 2. Volatile  | 4. Boiling |
- 5. The ratio between combining gas volumes and their gaseous product may be expressed in small whole numbers.
  - 6. Equal volumes of all gases under the same conditions contain equal numbers of molecules.

- |           |            |
|-----------|------------|
| 7. Oxygen | 11. 18.46  |
| 8. 16     | 12. 111.6  |
| 9. 58     | 13. 5.2    |
| 10. 60.3% | 14. $6O_2$ |

## True and false

- |       |       |
|-------|-------|
| 1. 0  | 14. + |
| 2. 0  | 15. 0 |
| 3. +  | 16. + |
| 4. 0  | 17. 0 |
| 5. 0  | 18. 0 |
| 6. +  | 19. 0 |
| 7. +  | 20. 0 |
| 8. 0  | 21. + |
| 9. +  | 22. + |
| 10. + | 23. 0 |
| 11. + | 24. + |
| 12. 0 | 25. + |
| 13. 0 | 26. + |

## Study Guide No. II

## The Structure of Atoms

1. Reviewing Dalton's Atomic Hypothesis
2. Discussion of the discovery of electrons
3. Discussion of the electrical nature of matter
4. Explanation of production of a charge of static electricity
5. Discussion of radium and the study of electrons
6. Discussion of the weight of the hydrogen atom
7. Illustration of the structure of the hydrogen atom

8. Discussion of the arrangement of electrons in an atom
9. Definition of the positron
10. Definition of atomic numbers
11. Accounting for the inactive characteristics of helium by the atomic structure theory
12. Illustrations of the diagrams of the oxygen, carbon, nitrogen, neon, fluorine atom structures

#### References

- Foster, The Romance of Chemistry, pp. 32-44.
- Holmes, Out of the Test Tube, pp. 137-158.
- Rawlins and Struble, Chemistry in Action, pp. 124-135.

#### Subject Matter No. II

#### The Structure of Atoms

- I. Development of the electron theory
  - A. Dalton's Atomic Theory
    1. Atomic structure of matter
    2. Atoms of the same element
    3. Atoms of different elements
    4. Uniting of different elements in compounds
    5. Destruction of atoms by ordinary chemical means
  - B. Work of Sir William Crookes and the vacuum tube
  - C. Work of Sir G. G. Thomson and the weight of the electron
  - D. Static electricity
    1. Friction
    2. Laws of
  - E. Radium
    1. Decomposition of
    2. Preparation of

## 3. Characteristics of

## II. Structure of the atom

## A. The hydrogen atom

1. Number of electrons
2. Number of protons
3. Diagram of structure

## B. The neutron

1. Charge of
2. Symbol of

## C. The oxygen atom

1. Number of electrons
2. Number of protons
3. Number of neutrons

## D. Arrangement of the electrons

## E. The positron

## F. Atomic numbers

1. Relation to protons
2. Relation to electrons

## G. Structure of some common elements

- |           |             |
|-----------|-------------|
| 1. Oxygen | 4. Nitrogen |
| 2. Neon   | 4. Helium   |
| 3. Carbon |             |

## Activities No. II

## The Structure of Atoms

- A. A short report on the lives of the Curies
- B. A report on the use of radium in medicine
- C. Presentation of the film "Electron - An Introduction" from Castle Films,

RCA Building, Rockefeller Center, New York 20, New York

- D. Presentation of the film "Romance of Radium," Teaching Films  
Custodians, 25 West 43rd Street, New York 18, New York

#### Correlations No. II

#### The Structure of Atoms

- A. Reading - Specific references
- B. Writing - Reports on the Curies and radium
- C. English - Reports on the Curies and radium
- D. Spelling - New terms such as proton, electron, neutron, positron

#### Work Sheet No. II

#### The Structure of Atoms

Complete the following with the proper word or phrase.

1. \_\_\_\_\_ electricity is created by friction between the surfaces of two bodies.
2. The X-ray tube works only because \_\_\_\_\_ from the cathode strike the anode and are deflected.
3. Radium also gives off \_\_\_\_\_ which helps to indicate that matter is made up of electricity.
4. The hydrogen atom contains one \_\_\_\_\_ and one \_\_\_\_\_.
5. The \_\_\_\_\_ is the positive charged part of the atom.
6. The neutral charged particle found in the nucleus of an atom is the \_\_\_\_\_.
7. In the structure of an atom there is always \_\_\_\_\_ electrons in the first ring.
8. The \_\_\_\_\_ is a positive charged particle found in protons in its nucleus.
10. Draw the structural pattern for the atoms whose atomic numbers are 8, 10, 16.

True and false. Mark the following true or false as they may read.

11. \_\_\_\_\_ All matter is thought to be made up of electricity.
12. \_\_\_\_\_ The electron is the heaviest part of the atom.
13. \_\_\_\_\_ In electricity like charges attract each other.
14. \_\_\_\_\_ There is only one kind of electricity and that is negative.
15. \_\_\_\_\_ X-rays are really a flow of electrons from the cathode.
16. \_\_\_\_\_ Radium yields electrons when it disintegrates.
17. \_\_\_\_\_ The electron weighs  $1/1845$  of that of the hydrogen atom.
18. \_\_\_\_\_ The protons revolve around the nucleus of the atom.
19. \_\_\_\_\_ The proton weighs  $1844/1845$  of that of the hydrogen atom.
20. \_\_\_\_\_ The neutron has no charge on it and weighs about as much as the proton.
21. \_\_\_\_\_ The number of protons and electrons in an atom are equal numerically.
22. \_\_\_\_\_ The atomic number represents the number of electrons in an atom.
23. \_\_\_\_\_ An atom of an atomic number of 6 will have six electrons.
24. \_\_\_\_\_ Those atoms with a complete outside ring are very active elements.
25. \_\_\_\_\_ The more electrons an atom can gain the more active it is.

#### Key to Work Sheet No. II

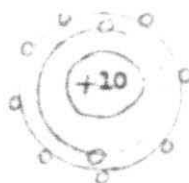
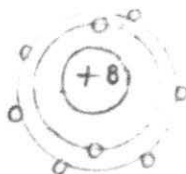
#### The Structure of Atoms

##### Completion:

- |                        |                  |
|------------------------|------------------|
| 1. Static              | 5. Proton        |
| 2. Electrons           | 6. Neutron       |
| 3. Electrons           | 7. 2             |
| 4. Electron and proton | 8. Positron      |
|                        | 9. Atomic number |



10.



True and false

11. +

12. 0

13. 0

14. 0

15. +

16. +

17. +

18. 0

19. +

20. +

21. +

22. 0

23. +

24. 0

25. 0

## Study Guide No. III

## Formation of Compounds

- A. Diagrams of the atoms of oxygen and hydrogen uniting to form water
- B. Diagrams of the atoms of carbon and oxygen uniting to form carbon dioxide
- C. Explanation of ways electrons are affected when a compound is formed
- D. Explanation of the difference of transferring of electrons and sharing of electrons
- E. Explanation of a negative valence or a positive valence
- D. Discussion of the value of valence
- G. Explanation of formation of ionic compounds
- H. Listing some common radicals, their formulas, and valence
- I. Explanation of the formation of covalent compounds
- J. Explanation of useage of valence in writing formulas for compounds
- K. Explanation of polar molecules
- L. Explanation of non-polar molecules

## References

- Poster, The Romance of Chemistry, pp. 52-57, 256-259.
- Rawlins and Struble, Chemistry in Action, pp. 136-146.
- Ahrens - Bush - Easley, Living Chemistry, (Sinn and Company, Chicago, Ill., 1949), pp. 39-51.
- Jaffe, New World of Chemistry, pp. 152-178.

## Subject Matter No. III

## Formation of Compounds

- I. Sharing of electrons
  - A. Formation of water
  - B. Formation of hydrogen molecules
  - C. Formation of ammonia gas
  - D. Formation of carbon dioxide
  - E. Diagrams of atoms showing the sharing of electrons
- II. Transferring of electrons
  - A. Formation of lithium fluoride
  - B. Transferring of electrons differs from sharing of electrons
  - C. Ions
- III. Valence
  - A. Electrons in the outer ring
  - B. Electrons lost or gained
  - C. Designation
    - 1. Negative
    - 2. Positive
  - D. Use of
    - 1. Different valences
    - 2. Writing formulas
    - 3. Writing the formulas for ions

## IV. Compounds

- A. Ionic
- B. Covalent
- C. Radicals

## V. Heavy water

## VI. Isotopes

## VII. Molecules

- A. Polar
- B. Non-polar

## Activities No. III

## Formation of Compounds

- A. Performing an experiment to show the behavior of solutions of ionic compounds and covalent compounds in conducting electric current
- B. Making a chart to show the valences of some common metals, non-metals and radicals
- C. Preparing electronic diagrams of the following compounds: (a)  $\text{HCl}$ , (b)  $\text{CO}_2$ , (c)  $\text{AlCl}_3$ , (d)  $\text{CH}_4$

## Correlations No. III

## Formation of Compounds

- A. Reading - Specific references
- B. Spelling - New terms of subject matter: radical, ion, electrovalent, covalent, isotopes
- C. English - Meaning of new terms, radical, ion, electrovalence, covalence, isotopes

## Work Sheet No. III

## Formation of Compounds

Mark the following statements true or false as they may read. Use the plus (+) for true and the zero (0) for false.

- \_\_\_\_\_ 1. In the formation of water the atoms in the molecule share electrons.
- \_\_\_\_\_ 2. Atoms that share electrons are said to be covalent.
- \_\_\_\_\_ 3. The sharing of electrons results in the formation of ions.
- \_\_\_\_\_ 4. Covalent compounds are poor conductors of electricity when in solution.
- \_\_\_\_\_ 5. In forming of compounds only the electrons in the outer ring are involved.
- \_\_\_\_\_ 6. In the formation of such compounds as sodium chloride there is a transfer of electrons.
- \_\_\_\_\_ 7. Those atoms that transfer electrons are said to be electrovalent.
- \_\_\_\_\_ 8. A solution of hydrogen sulfate will conduct electricity therefore it is electrovalent.
- \_\_\_\_\_ 9. An atom that gains two electrons will have a valence of -2.
- \_\_\_\_\_ 10. An atom will gain or lose electrons only in the outer ring.
- \_\_\_\_\_ 11. An atom that loses six electrons will have a valence of -6.
- \_\_\_\_\_ 12. Each atom has only one valence.
- \_\_\_\_\_ 13. Radicals are a group of atoms that behave as a unit in forming compounds.
- \_\_\_\_\_ 14. Radicals may have a valence the same as an atom.
- \_\_\_\_\_ 15. The usual valence of hydrogen is a -1.
- \_\_\_\_\_ 16. All metals present a positive valence.
- \_\_\_\_\_ 17. Carbon may have a valence of either a + or - four.
- \_\_\_\_\_ 18. In a chemical formula the + and - charges must be equal.
- \_\_\_\_\_ 19. Hydrogen always has one proton and one electron in its atom and may have no more.
- \_\_\_\_\_ 20. Atoms may have different atomic weights.
- \_\_\_\_\_ 21. Molecules that behave as magnets are said to be polar molecules.

- \_\_\_\_ 22. Electrovalent molecules are polar molecules.
- \_\_\_\_ 23. Polar molecules are formed by atoms sharing electrons.
- \_\_\_\_ 24. Non-polar molecules are produced by atoms transferring electrons.
- \_\_\_\_ 25. Covalent molecules are polar molecules.

Complete the following:

26. Write the formula for sodium chloride using the valence of each atom.
27. Give the symbols and valence for the radical in sulfuric acid, nitric acid, water, sodium hydroxide, calcium phosphate.
28. An \_\_\_\_\_ is a charged atom formed by the transferring of electrons.
29. Molecules may be formed by either \_\_\_\_\_ or \_\_\_\_\_ electrons by the atoms involved.
30. \_\_\_\_\_ is one of two or more kinds of atoms having the same chemical properties, but different atomic weights.

#### Key to Work Sheet No. III

#### The Formation of Compounds

True and false

- |      |       |       |
|------|-------|-------|
| 1. + | 9. +  | 17. + |
| 2. + | 10. + | 18. + |
| 3. 0 | 11. 0 | 19. 0 |
| 4. + | 12. 0 | 20. + |
| 5. + | 13. + | 21. + |
| 6. + | 14. + | 22. + |
| 7. + | 15. + | 23. 0 |
| 8. + | 16. + | 24. 0 |
|      |       | 25. 0 |

Completion

26. Sodium

Chlorine

Na

Cl

Na +

+

Cl<sup>-</sup>

NaCl

27.  $\text{SO}_4^{--}$ ,  $\text{NO}_3^{--}$ ,  $\text{OH}^-$ ,  $\text{PO}_4^{--}$ 

28. Ion

29. Sharing, transferring

30. Isotope

## Study Guide No. IV

## Transmutation of Elements

- A. Explanation of the transmutation of an element
- B. Explanation of how the method used today differs from that of the alchemist
- C. Explanation of the subscripts and exponents in the equation  

$${}_{7}^{14}\text{N} + 2{}_{2}^{4}\text{He} \longrightarrow {}_{8}^{17}\text{O} + {}_{1}^{1}\text{H}$$
- D. Explanation of the mass number of an element
- E. Description of the cloud chamber
- F. Explanation of the breaking up of an atom
- G. Description of the cyclotron
- H. Discussion of the production of artificial radioactivity
- I. Discussion of the difference between Uranium 235 and 238
- J. Explanation of atomic fission
- K. Discussion of the production of Neptunium and Plutonium
- L. Discussion of other recently discovered radioactive elements

## References

- Rawlins and Struble, Chemistry in Action, pp. 146-154.  
Ahrens - Bush - Easley, Living Chemistry, pp. 530-534.  
Bibble - Bush, Chemistry Today, pp. 200-210.  
Carleton - Carpenter, Chemistry for the New Age, pp. 224-238.

## Subject Matter No. IV

## Transmutation of Elements

## I. Transmutation

- A. Definition of
- B. Equations of
  - 1. Superscripts
  - 2. Subscripts
  - 3. Mass number

## C. Discovery of

## II. Cloud chamber

- A. Use of
- B. Operation of
- C. Breaking down of elements
- D. Particles used
  - 1. Alpha (helium nuclei)
  - 2. Hydrogen nuclei (protons)
  - 3. Heavy hydrogen nuclei (deuterons)
  - 4. Neutrons

## III. Cyclotron

- A. Use of
- B. Dangers of
- C. Operation of

## IV. Radioactivity

- A. History
- B. Bcron
- C. Uses of radioactive elements

## V. The atomic bomb

- A. Materials
  - 1. U. 238
  - 2. U. 235
- B. Fission
- C. Changes involved
- D. Methods of obtaining materials
  - 1. Diffusion
  - 2. Preparation of Plutonium
    - a. U-238
    - b. Neptunium

## Activities No. IV

## Transmutation of Elements

- A. Preparation of a report of the peace time uses of atomic energy
- B. Preparation of a report on the life of Madam Curie
- C. Preparation of a report on the use of radioactive elements in medicine
- D. Preparation of a report on the use of atomic energy in war time

## Work Sheet No. IV

## Transmutation of Elements

Complete the following statements to make them read correctly.

- 1. The \_\_\_\_\_ were a group of men who first attempted to change one element into another.
- 2. \_\_\_\_\_ is the process of changing one element into another.



3. In the formula  ${}^7\text{N}^{14}$ , the 14 is the \_\_\_\_\_ number and the 7 is the \_\_\_\_\_ number.
4. The scientist \_\_\_\_\_ was one of the first men to change one element into another.
5. The \_\_\_\_\_ is used to make photographs of the changes involved in the bombardment of elements.
6. \_\_\_\_\_ is used to produce a fog track in the cloud chamber.
7. Elements are sometimes bombarded with \_\_\_\_\_ particles, hydrogen \_\_\_\_\_ and \_\_\_\_\_.
8. The \_\_\_\_\_ is frequently used in bombarding elements because it is neutral.
9. The \_\_\_\_\_ is an instrument used to increase the velocity of positively charged atomic particles.
10. The cyclotron uses two \_\_\_\_\_ to alternately attract the atomic particles.
11. The isotope \_\_\_\_\_ of uranium is used in the atomic bomb.
12. \_\_\_\_\_ is the splitting of an atom by bombardment.
13. The two new elements made in the transmutation of Uranium 235 are \_\_\_\_\_ and \_\_\_\_\_.
14. Plutonium is made from \_\_\_\_\_ by first converting it into \_\_\_\_\_.
15. The last two known elements are radioactive and are called \_\_\_\_\_ and \_\_\_\_\_.

Mark the following statements true or false as the statement may read.

Use the plus (+) for true and the minus (-) for false.

- \_\_\_\_\_ 1. The helium nuclei is also called an alpha particle.
- \_\_\_\_\_ 2. In the formula  ${}^7\text{N}^{14}$  the seven is the atomic number.

- \_\_\_\_\_ 3. Many elements may be made artificially radioactive.
- \_\_\_\_\_ 4. The artificial radioactive elements are used in medicine.
- \_\_\_\_\_ 5. The bombardment of an atom with an atomic particle is a haphazard process.
- \_\_\_\_\_ 6. The speed of the bombarding particle is very fast and it cannot be aimed.
- \_\_\_\_\_ 7. Uranium 238 can be used in the atomic fission of the atom bomb.
- \_\_\_\_\_ 8. Uranium 238 may be converted into uranium 235.
- \_\_\_\_\_ 9. Americium is a radioactive element that has to be synthetically produced.
- \_\_\_\_\_ 10. Only a very small part of uranium ore is composed of uranium 235.

#### Key to Work Sheet No. IV

#### Transmutation of Elements

#### Completion

- |                            |                            |
|----------------------------|----------------------------|
| 1. Alchemists              | 9. Cyclotron               |
| 2. Transmutation           | 10. Electromagnets         |
| 3. Mass, atomic            | 11. 235                    |
| 4. Rutherford              | 12. Fission                |
| 5. Cloud chamber           | 13. Barium, krypton        |
| 6. Water                   | 14. Uranium 238, neptunium |
| 7. Alpha, nuclei, neutrons | 15. Americium, curium      |
| 8. Neutron                 |                            |

#### True or false

- |      |       |
|------|-------|
| 1. + | 6. +  |
| 2. + | 7. 0  |
| 3. + | 8. 0  |
| 4. + | 9. +  |
| 5. + | 10. + |

## Study Guide No. V

## Chemical Equations

- A. Discussion of information in a chemical equation
- B. Listing of the steps in writing a chemical equation
- C. Listing of the steps in balancing an equation
- D. Discussion of the types of problems involving the use of equations
- E. Completing the equations:
  1.  $\text{KClO}_3 \longrightarrow \text{KCl} + \text{O}_2$
  2.  $\text{Zn} + \text{H}_2\text{SO}_4 \longrightarrow \text{ZnSO}_4 + \underline{\hspace{2cm}}$
  3.  $\text{Al} + \text{HCl} \longrightarrow \text{AlCl}_3 + \underline{\hspace{2cm}}$
- F. Solving how much  $\text{KClO}_3$  it takes to produce 3 grams of  $\text{O}_2$
- G. Solving for the volume of hydrogen required to unite with 500 ml of  $\text{O}_2$
- H. Solving for the volume of  $\text{O}_2$  obtained from 10 gms. of mercuric oxide

## References

- Rawlins and Struble, Chemistry in Action, pp. 155-160.
- Carleton and Carpenter, Chemistry for the New Age, pp. 244-256.
- Ahrens - Bush - Easley, Living Chemistry, pp. 77-92.

## Subject Matter No. V

## Chemical Equations

## I. Equations

- A. "Chemical shorthand"
  1. Symbols
  2. Formulas
  3. Equations
- B. Reasons for using
  1. Conciseness
  2. Exactness
  3. Represents relative quantities

- a. By weight
- b. By volume
- 4. Solving problems
  - a. Quantity of product produced
  - b. Amount needed
  - c. Theoretical yield
  - d. Gives correct formulas for
    - (1) Reacting products
    - (2) Products produced
- C. Writing an equation
  - 1. A word equation
  - 2. Symbol or formula for each substance
  - 3. Number of atoms in equation
  - 4. Balancing of atoms
  - 5. Balancing by changing number of molecules
  - 6. Balancing by inspection

## II. Chemical problems

### A. Weight

- 1. Balanced equation for reaction
- 2. Determining relative weights of chemicals
- 3. Placing these values under each substance (equation weights)
- 4. Placing data given in problem over the correct substance (problem weights)
- 5. Equation weights - Total of atomic weights for each substance
- 6. Solve by proportion

### B. Volume

- 1. A balanced equation for the reaction
- 2. Placing the given volumes above their respective formulas

3. Coefficients - The relative volumes of the gases

C. Weight - Volume

1. A balanced equation for the reaction
2. Determining relative weight of chemical
3. Placing the data given in the problem above the correct substance
4. Placing the volume represented by the gram-molecular weight of a gaseous substance below the gas involved
5. Solving by proportion

Activities No. V

Chemical Equations

- A. Completing and balancing equations in Chemistry in Action, pp. 156-157.
- B. Solving problems on weight in Chemistry in Action, p. 158.
- C. Solving problems on volume in Chemistry in Action, p. 159.
- D. Solving problems on weight - volume in Chemistry in Action, p. 160.
- E. Solving problems in group B in Chemistry in Action, p. 160.

Correlations No. V

Chemical Equations

- A. Writing - Writing equations
- B. Reading - Specific references
- C. Mathematics - Problems on volume, weight, and volume-weight combined

Work Sheet No. V

Chemical Equations

Complete - Giving the answer on a separate piece of paper.

1. Write the symbols for hydrogen, oxygen, chlorine, potassium, carbon, nitrogen, sulfur, sodium.
2. Write the formula for sodium chloride, sulfuric acid, nitric acid,

water, hydrogen, oxygen, potassium chlorate, potassium chloride.

3. Write a balanced equation for:
  - a. Sulfuric acid upon zinc
  - b. Decomposition of potassium chlorate
  - c. Burning of sugar
  - d. Sodium on water
  - e. Sodium hydroxide and hydrochloric acid
4. List three types of problems that can be solved by using an equation
5. When 5 grams of zinc reacts with sulfuric acid, how many grams of hydrogen are formed?
6. How many grams of oxygen can be secured by heating 72.5 grams of potassium chlorate?
7. Hydrogen unites with nitrogen yielding ammonia gas,  $\text{NH}_3$ . How many liters of nitrogen are required to unite with 10 liters of hydrogen?
8. How many liters of oxygen can be secured from 50 grams of potassium chlorate?

#### Key to Work Sheet No. V

##### Chemical Equations

1. Hydrogen, H; Oxygen, O; chlorine, Cl; potassium, K; carbon, C; nitrogen, N; sulfur, S; sodium, Na.
2. Sodium chloride,  $\text{NaCl}$ ; sulfuric acid,  $\text{H}_2\text{SO}_4$ ; nitric acid,  $\text{HNO}_3$ ; water,  $\text{H}_2\text{O}$ ; hydrogen,  $\text{H}_2$ ; oxygen,  $\text{O}_2$ ; potassium chlorate,  $\text{KClO}_3$ ; potassium chloride,  $\text{KCl}$ .
3. a.  $\text{H}_2\text{SO}_4 + \text{Zn} \xrightarrow{\text{CuSO}_4} \text{ZnSO}_4 + \text{H}_2$   
 b.  $2\text{KClO}_3 \xrightarrow{\text{MnO}_2} 2\text{KCl} + 3\text{O}_2$   
 c.  $\text{C}_6\text{H}_{12}\text{O}_6 \longrightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$   
 d.  $2\text{Na} + 2\text{H}_2\text{O} \longrightarrow 2\text{NaOH} + \text{H}_2$   
 e.  $\text{NaOH} + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$

4. Weight, volume, weight-volume combination
5. .15 g.
6. 28.5 g.
7. 3 1/3 l.
8. .611.

#### Culminating Activities

##### The Structure of Matter

- I. Organizing a visit to the local health department for a demonstration on the use of the X-ray and its operation
- II. Discussion by a local doctor on the use of radium in treatment of disease
- III. Performing by students an experiment on the preparation of 500 cc. of oxygen by the decomposition of potassium chlorate

#### Desirable Outcomes

##### The Structure of Matter

- I. Knowledge and Understanding of:
  - A. The nature of molecules
    1. Definition - The smallest particle of an element or compound that exists by itself and has the properties of the original substance
    2. Made up of atoms
    3. Smallest particle of a gas
    4. Always in motion
    5. Intermingle in gases
    6. Particles in solids and gases
    7. Diffusion
      - a. Scattering of molecules
      - b. Volatile - To evaporate

- c. Caused by molecular motion
- d. Takes place in solids and liquids
- e. Slower in solids and liquids
- 8. Osmosis
  - a. Passing of molecules through moist membrane
  - b. Passing from a high to a low concentration
- 9. Space between molecules
- 10. Effect of heat
  - a. Increases motion
  - b. Vapor pressure
    - (1) Due to motion of molecules
    - (2) Increases with temperature
    - (3) Boiling
      - (a) Affected by atmospheric pressure
      - (b) Different for each substance
      - (c) Vapor pressure exceeding atmospheric pressure
    - (4) Affects volume of gas over water

## B. The Kinetic-Molecular Theory

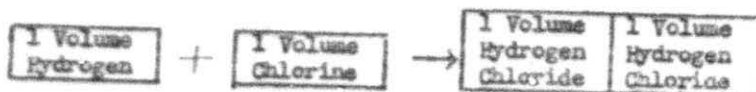
- 1. Matter
  - a. Composed of very small particles
  - b. Molecules in gases and liquids
- 2. Molecules
  - a. Very elastic
  - b. Move with varying velocities
  - c. Space between each
  - d. Collision causes pressure
  - e. Movement



- (1) Restricted in solids and liquids
- (2) Unrestricted in gases
- (3) Increases with temperature

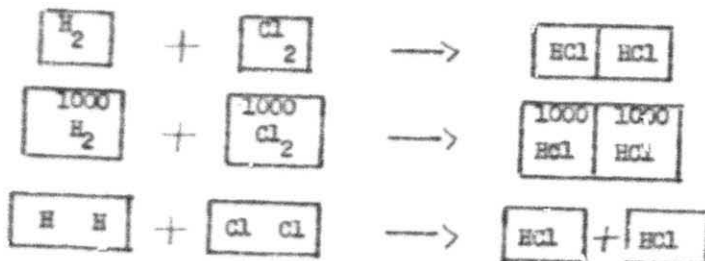
C. Gay-Lussac's Law

1. True for gases
2. Uniting of gas volumes
  - a. Expressing ratio of combining gas volumes and their products in small whole numbers
3. Illustration



D. Avagadro's Law

1. Combining of gas volumes
2. Equal volumes of gases containing equal number of molecules
3. Graphic illustration



4. Combining of two atoms to make one gas molecule

E. Weights

1. Necessary for comparison
2. Relative units
3. Atomic weights
  - a. Based on oxygen
  - b. Oxygen at 16

c. Relative ratio

#### 4. Molecular weights

a. Sum of atomic weights

b. Illustration -  $\text{KClO}_3$

$$K = 39 + Cl = 35 + O = 16 \times 3$$

$$39 + 35 + 48 = 122$$

c. Experimentally

(1) Avagadro's Law

(a) One molecular weight of a gas = 22.4 liters

(b) Determining weight of one liter

(c) Multiplying by 22.4

(2) Freezing point

(a) Lowering of freezing point by one gram-molecular weight

(b) Covalent compounds only

(c)  $1.86^\circ\text{C}$  per liter

(3) Boiling point

(a) Raising of boiling point by one gram-molecular weight

(b) Covalent compounds only

(c)  $.52^\circ\text{C}$  per liter

#### 5. Uses

a. Percentage composition

(1) Determine total molecular weight

(2) Divide by the atomic weight of element involved

(3) Illustration -  $\text{KClO}_3$

$$K = 39 + Cl = 35 + O = 16 \times 3$$

$$39 + 35 + 48 = 122$$

$$\frac{48}{122} \approx 40\% \text{ O}_2$$

## b. Determination of formulas

- (1) Experimental work
  - (a) Elements present
  - (b) Proportions on per cent
  - (c) Molecular weight
- (2) Per cent of each element
- (3) Divide by atomic weight
- (4) Gives atomic ratio
- (5) Dividing atomic ratio by smallest
- (6) Converting to whole numbers
- (7) Illustration -  $\text{CO}_2$

$$(a) \text{ Carbon } \frac{27.3\%}{12} = 2.27$$

$$\text{Oxygen } \frac{72.7\%}{16} = 4.54$$

$$(b) \frac{2.27}{2.27} = 1 \text{ C}$$

$$\frac{4.54}{2.27} = 2 \text{ O}$$

$$(c) \text{ Formula } = \text{CO}_2$$

## F. The structure of atom

### 1. Matter

- a. Composed of electricity
- b. Current electricity
  - (1) Flow of electrons
  - (2) Passes across a vacuum
  - (3) Cathode rays

(a) Composed of particles

(b) Called electrons

c. Static electricity

(1) Caused by friction

(2) Positive and negative

(3) Like charges repel

(4) Unlike charges attract

## 2. Radium

a. Decomposes freeing electrons

b. Found in luminous dials

c. Discovered by Curies

d. Decomposes into

(1) Gamma rays

(2) Alpha rays (helium nuclei)

(3) Beta rays (electrons)

## 3. Hydrogen atom

a. Weight of one

b. Electron weight  $\frac{1}{1836}$  of hydrogen atom

c. Neutral in charge

d. Weight due to proton

e. Proton weight -  $\frac{1836}{1836}$  of hydrogen atom

f. Contains one proton and electron

g. Graphic illustration



o Electron

+ Proton

## h. Neutron

a. No electrical charge

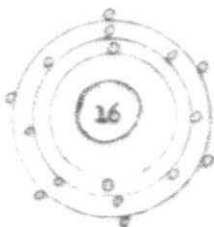
b. Composed of electron and proton

## 5. Electron arrangement

## a. Bohr's "solar system atom"

- (1) 2 electrons in first ring
- (2) 8 electrons in second ring
- (3) 8 to 18 electrons in third ring
- (4) 8 to  $\infty$  electrons in fourth ring

## b. Graphic illustration



## 6. Atomic number

- a. Number of protons in nucleus
- b. Number of electrons the same

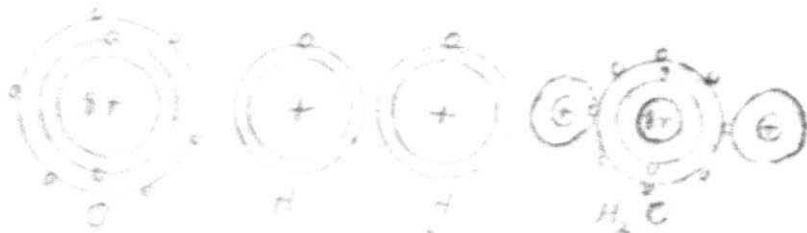
## 7. Chemical activity of element

- a. Determined by electrons on outer orbit
- b. Three or less a metal
- c. Five or more a non-metal

## 8. Formation of compounds

## 1. Sharing of electrons

- a. Covalent compounds
- b. Non-ionizing
- c. Water an example
- d. Graphic illustration



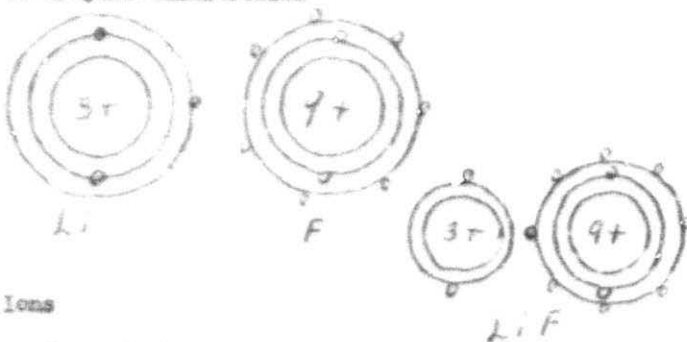
## 2. Exchange of electrons

## a. Electrovalent compounds

## b. Ions

## c. Lithium fluoride as an illustration

## d. Graphic illustration



## 3. Ions

## a. Charged atoms

## b. Loss or gain of electrons

## 4. Valence

## a. Gain or loss of electrons

## b. Gain of electrons - Negative

## c. Loss of electrons - Positive

## 5. Types of compounds

## a. Electrovalent - Transfer of electrons

## b. Covalent - Sharing of electrons

## 6. Determining formula for compound

## a. Write symbol of element or radical

## b. Positive element first

## c. Indicate valence of each

## d. Only negative and positive combine

## e. Negative valence = positive valence

## 7. Isotope

## a. Same chemical properties

b. Different atomic weights

8. Polar molecules - Transferring of electrons

9. Non-polar molecules - Sharing of electrons

#### E. Transmutation of elements

1. Changing one element into another

2. Nuclear reaction equation



a. Superscripts - Number of protons and neutrons

b. Subscripts - Atomic number

c. Mass number - Sum of protons and neutrons

3. Cloud chamber - To photograph nuclear reactions

4. Methods of changing by bombardment with

a. Alpha particle (helium nuclei)

b. Hydrogen nuclei (protons)

c. Heavy hydrogen nuclei (deutrons)

d. Neutrons

5. Cyclotron

a. Increasing speed of charged particle

b. Electromagnetic device

c. Increasing speed of positive particle

6. Artificial radioactivity

a. Useful in medicine

b. Inexpensive

c. Short time life

7. Atomic bomb

a. Uranium

(1) Several isotopes

(2) Most common - U - 238

(3) Traces of U - 235

(4) Fission

(a) Splitting of atom

(b) By bombardment

(5) U - 235

(a) Split by neutrons

(b) Products - Barium and krypton

(c) Chain reaction

(d) Continues until U - 235 exhausted

(6) U - 238 unusable

(7) Separation of U - 235 and U - 238 by porous barrier

#### b. Plutonium

(1) Used in atomic bomb

(2) More plentiful

(3) Produced from U - 238

(4) U - 239 first formed

(5) U - 239 becomes Neptunium

(6) Changing of Neptunium into Plutonium

#### I. Chemical equations

1. Shorthand story of chemical reaction

2. Method of writing

a. Word equation

Hydrogen + Oxygen  $\longrightarrow$  Water

b. Symbol equation



c. Balance number of atoms

d. Cannot change subscripts



e. Add coefficients to increase number of atoms

3. Chemical problems

a. Weight problems

- (1) Balance equation
- (2) Determine relative weights
- (3) Determine molecular weight
- (4) Solve by proportion

b. Volume

- (1) Balance equation
- (2) Placing volume above respective formula
- (3) Coefficient - Indicating relative volume
- (4) Solve by proportion

II. Attitude toward:

- A. The development of the Molecular Theory
- B. The explanation of the properties of matter
- C. The work of the chemist in explaining the behavior of matter
- D. The usefulness of the atomic theory
- E. Improvements in everyday living by chemistry
- F. Advantages of good study habits
- G. The use of study guides in studying
- H. Usefulness of transmutation of element
- I. Dangers of the transmutation of the elements
- J. Affect of the atomic bomb upon life

III. Habit of:

- A. Reading scientific articles on atomic fission
- B. Trying to understand recent scientific discoveries
- C. Being neat in all work

- D. Being exact in all work
- E. Completing all work started
- F. Using study guides in studying
- G. Writing chemical equations for all chemical reactions
- H. Respecting the work of the chemist in promoting health

#### IV. Appreciation for:

- A. New discoveries by experimentation
- B. Explaining scientific principles by experimentation
- C. Radioactivity - Its discovery and usefulness
- D. The electron - Its discovery and usefulness
- E. The work of the chemist in promoting the welfare of man
- F. The completeness of scientific work
- G. Good study habits
- H. Good workmanship

#### Leads to Other Units

#### The Structure of Matter

If the student has mastered some of the basic principles of this unit he should be able to understand more completely the principles in the following units.

- IV. Theory of Solutions
- V. Nitrogen and Its Compounds
- VI. The Wonder Element - Carbon
- VII. The Periodic Law and Chemical Families
- VIII. Some Important Non-Metals
- IX. The Metals

Teacher Evaluation  
The Structure of Matter

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free informal associations of pupils?
3. Provide an opportunity for manipulative activity?
4. Make a coherent whole?
5. Provide a considerable amount of student activity?
6. Produce satisfying outcomes?
7. Provide sufficient concrete and illustrative material?
8. Have a useful purpose in the present and future?
9. Reproduce actual life situations as far as possible?
10. Utilise materials as they occur in life?
11. Contain some accurate material?
12. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
✓					
	✓				
✓					
	✓				
		✓			
		✓			
		✓			
		✓			
✓					

13. Provide opportunity to judge, choose and evaluate?
14. End lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete, exact references?

Ex.	V.G.	C	F	P.	None
		/			
/					
	/				
	/				
/					

#### Pupil Test

#### Knowledge Test

#### The Structure of Matter

Complete the following with the correct word or words to make the statement read correctly.

- All matter is made up of very small particles called \_\_\_\_\_.
- \_\_\_\_\_ Law states that equal volumes of gases under the same conditions contain an equal number of molecules.
- The atomic weight of oxygen is \_\_\_\_\_.
- The atomic weight of hydrogen is approximately \_\_\_\_\_.
- \_\_\_\_\_ electricity is created by friction between the surfaces of two bodies.
- The \_\_\_\_\_ is the positive charged particle in the nucleus of the atom.
- The \_\_\_\_\_ is the negative charged particle of the atom and rotates around the nucleus.

8. The atomic number of an element is the number of \_\_\_\_\_ in the nucleus of the atom.
9. Draw the structural pattern of an atom whose atomic number is 10.
10. Covalent compounds are formed by the \_\_\_\_\_ of electrons.
11. \_\_\_\_\_ compounds are formed by transferring electrons.
12. An \_\_\_\_\_ is a charged atom which has lost or gained electrons.
13. An \_\_\_\_\_ is one of two or more kinds of atoms having the same chemical properties, but different atomic weights.
14. \_\_\_\_\_ is the process of changing one element into another element.
15. The \_\_\_\_\_ is used to make photographs of the changes made in the bombardment of elements.
16. The \_\_\_\_\_ is frequently used to bombard atoms because it is neutral.
17. The \_\_\_\_\_ is a device used to greatly increase the velocity of positive charged particles.
18. The isotope \_\_\_\_\_ of uranium is used in the atomic bomb.
19. U - 238 is converted into \_\_\_\_\_ which can be used in the atomic bomb.
20. In the formula  ${}_7^{14}\text{N}$  the superscript 14 represents the \_\_\_\_\_ and the subscript 7 is the \_\_\_\_\_.
- Mark the following statements true or false using the plus (+) for true and the zero (0) for false.
- \_\_\_\_ 21. All molecules of the same substance are alike in size and chemical behavior.
- \_\_\_\_ 22. Diffusion can take place only in gases.

- \_\_\_\_\_ 23. A molecule of oxygen contains only one atom.  
 \_\_\_\_\_ 24. Molecules of all substances are in constant motion.  
 \_\_\_\_\_ 25. Molecules of liquids move faster than molecules of solids.  
 \_\_\_\_\_ 26. Osmosis takes place only because molecules are in motion.  
 \_\_\_\_\_ 27. The pressure of a gas is due to the motion of the molecules.  
 \_\_\_\_\_ 28. Automobile tires have less air pressure inside them in the morning than at noon on a warm day.  
 \_\_\_\_\_ 29. The increase in tire pressure of an automobile tire during a drive is due to it picking up air.  
 \_\_\_\_\_ 30. The electron is the heaviest part of an atom.  
 \_\_\_\_\_ 31. In electricity unlike charges repel one another.  
 \_\_\_\_\_ 32. Electricity is a flow of electrons.  
 \_\_\_\_\_ 33. The protons revolve around the nucleus of an atom.  
 \_\_\_\_\_ 34. In an atom of an atomic weight of 7 there will be 7 electrons.  
 \_\_\_\_\_ 35. All inactive elements have either 2 or 8 electrons in the outer orbit.  
 \_\_\_\_\_ 36. Those atoms that gain electrons have a positive valence.  
 \_\_\_\_\_ 37. Atoms that transfer electrons are said to be electrovalent.  
 \_\_\_\_\_ 38. An atom that loses two electrons will have a valence of -2.  
 \_\_\_\_\_ 39. An atom may have more than one valence.  
 \_\_\_\_\_ 40. An atom may have more than one atomic weight.  
 \_\_\_\_\_ 41. U - 238 cannot be used in the atomic bomb.  
 \_\_\_\_\_ 42. X-rays are formed from radioactive elements.

Complete the following equations

43.  $\text{Zn} + \text{H}_2\text{SO}_4 \longrightarrow \text{ZnSO}_4 + \text{_____}$   
 44.  $\text{KClO}_3 \longrightarrow \text{KCl} + \text{_____}$   
 45.  $\text{Mg} + \text{_____} \longrightarrow \text{MgO}$

Write the formula for

46. Sodium chloride  
47. Hydrogen chloride  
48. Hydrogen sulfate

Solve the following problems

49. What volume of  $H_2$  is required to react with 500 ml. of  $O_2$ ?  
50. How much  $KClO_3$  is needed to produce 1.43 grams of  $O_2$ ?

### Key to Knowledge Test

#### The Structure of Matter

- |  |                 |   |
|--|-----------------|---|
| 1. Molecules   | 18. U - 235     | 35. +   |
| 2. Avogadro  | 19. Plutonium   | 36. 0   |
| 3. 16  | 20. Mass number | 37. +   |
| 4. 1   | Atomic number   | 38. +   |
| 5. Static  | 21. +           | 39. +   |
| 6. Proton  | 22. 0           | 40. +   |
| 7. Electron  | 23. 0           | 41. +   |
| 8. Protons   | 24. +           | 42. 0   |
| 9.  | 25. +           | 43. $Zn + H_2SO_4 \xrightarrow{CuSO_4} ZnSO_4 + H_2 \uparrow$ |
| 10. Sharing  | 26. +           | 44. $2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$                 |
| 11. Polar  | 27. +           | 45. $2Mg + O_2 \longrightarrow 2MgO$                          |
| 12. Ion  | 28. +           | 46. NaCl  |
| 13. Isotope  | 29. 0           | 47. HCl   |
| 14. Transmutation  | 30. 0           | 48. $H_2SO_4$   |
| 15. Cloud chamber  | 31. 0           | 49. 1000  |
| 16. Neutron  | 32. +           | 50. 3.65 g.   |
| 17. Cyclotron  | 33. 0           |   |
|  | 34. +           |   |

Pupil Test  
Attitude Test

The Structure of Matter

Mark the following statements by placing a yes or no before each one.

- \_\_\_\_\_ 1. Does the knowledge of molecules help you explain the nature of matter?
- \_\_\_\_\_ 2. Do you think that the field of chemistry as being aided by the Molecular Theory?
- \_\_\_\_\_ 3. Do you feel that the idea of molecules will be discarded in the future?
- \_\_\_\_\_ 4. Do you now feel that the air is a mixture of gases?
- \_\_\_\_\_ 5. Do you think that the explanation of diffusion is logical and reasonable?
- \_\_\_\_\_ 6. Do you understand the process of evaporation more than you did before?
- \_\_\_\_\_ 7. Do you think it will ever be possible to change some cheap metal into gold?
- \_\_\_\_\_ 8. Do you feel that the alchemist were foolish in trying to change one element into another?
- \_\_\_\_\_ 9. Do you feel that Gay-Lussac's Law is logical and an aide to chemistry?
- \_\_\_\_\_ 10. Does Avogadro's Law help you to explain how gases combine by volume?
- \_\_\_\_\_ 11. Do you feel that Avogadro's Law is logical and reasonable?
- \_\_\_\_\_ 12. Do you feel that the system of atomic weights is incorrect and unreasonable?
- \_\_\_\_\_ 13. Do you feel that there is enough experimental evidence to support the system of atomic weights?



- \_\_\_\_ 14. Do you feel that the field of chemistry could be greatly appreciated without problems?
- \_\_\_\_ 15. Does a knowledge of chemistry help you to understand how anti-freeze keeps your car from freezing up?
- \_\_\_\_ 16. Do you feel that the chemical formulas are reasonably correct and accurate?
- \_\_\_\_ 17. Do you think the world would have been better off without the atomic fission discovery?
- \_\_\_\_ 18. Do you think the idea that basically all matter is composed of electricity is correct?
- \_\_\_\_ 19. Do you feel that discovery of the X-ray was important to mankind?
- \_\_\_\_ 20. Do you feel that radioactivity can be made very helpful to man?
- \_\_\_\_ 21. Do you feel that we should discontinue all atomic energy research?
- \_\_\_\_ 22. Do you feel that all atomic energy information should be made public?
- \_\_\_\_ 23. Do you feel that the idea of atomic energy will be more helpful to man than harmful?
- \_\_\_\_ 24. Do you think chemistry has made worth while contributions to man?
- \_\_\_\_ 25. Do you think the explanation of how compounds are formed is practical and reasonable?

Pupil Test

Habit Test

The Structure of Matter

Answer the following questions with a yes or no placed before each statement.

- \_\_\_\_ 1. Do you read your study guides and use them in your study?
- \_\_\_\_ 2. Do you study each assignment as it is given to you?
- \_\_\_\_ 3. Do you study each assignment at the earliest possible time?

- \_\_\_\_\_ 4. Do you perform all laboratory experiments assigned to you?
- \_\_\_\_\_ 5. Do you perform all laboratory experiments as completely as possible?
- \_\_\_\_\_ 6. Do you put your equipment away dirty after you have used it?
- \_\_\_\_\_ 7. Do you solve all problems assigned to you in chemistry?
- \_\_\_\_\_ 8. Do you solve only the problems that are easy and quickly solved?
- \_\_\_\_\_ 9. Do you use the "chemical short hand" method of writing the chemical equations?
- \_\_\_\_\_ 10. Do you read newspaper and magazine articles on atomic fission?
- \_\_\_\_\_ 11. Do you read newspaper and magazine articles when they relate to chemistry?
- \_\_\_\_\_ 12. Do you use Avogadro's Law to explain how gases combine by volume?
- \_\_\_\_\_ 13. Do you take only the required amounts of chemicals needed?
- \_\_\_\_\_ 14. Do you return all unused portions of chemicals to the reagent bottles?
- \_\_\_\_\_ 15. Do you study in the proper environment?

#### Key to Habit Test

#### The Structure of Matter

The desirable answer is yes for all questions except numbers 6, 8, and 14.

#### Pupil Test

#### The Structure of Matter

#### Appreciation Test

Answer the following questions by placing a yes or no before each one.

- \_\_\_\_\_ 1. Do you appreciate the idea of molecules and how it helps us explain the nature of matter?
- \_\_\_\_\_ 2. Do you appreciate the explanation of osmosis and how it helps us understand our bodies?

- \_\_\_\_\_ 3. Do you appreciate the explanation of evaporation?
- \_\_\_\_\_ 4. Do you appreciate the usefulness of the chemist's "shorthand" in writing chemical reactions?
- \_\_\_\_\_ 5. Do you appreciate X-ray and its usefulness to man?
- \_\_\_\_\_ 6. Do you appreciate the explanation of how X-ray works?
- \_\_\_\_\_ 7. Do you appreciate the discovery of radioactivity?
- \_\_\_\_\_ 8. Do you appreciate the usefulness of radioactivity in medicine?
- \_\_\_\_\_ 9. Do you appreciate the explanation of radioactivity?
- \_\_\_\_\_ 10. Do you appreciate the atomic theory and how it helps us to understand chemical reactions?
- \_\_\_\_\_ 11. Do you appreciate the discovery of atomic energy?
- \_\_\_\_\_ 12. Do you appreciate the explanation of how compounds are formed?
- \_\_\_\_\_ 13. Do you appreciate the field of chemistry more than you did at the first of the course?
- \_\_\_\_\_ 14. Do you appreciate the laboratory work?
- \_\_\_\_\_ 15. Do you appreciate how chemistry helps us to understand the behavior of matter?

#### Key to Appreciation Test

#### The Structure of Matter

The desirable answer to all questions is yes.

#### Bibliography

#### The Structure of Matter

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#### Pupil

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#### Unit No. IV

##### Theory of Solutions

The changes that occur when substances dissolved are commonplace yet interesting. When small amounts of salt, sugar, or many other common substances are dissolved in water they vanish. Our sense of taste tells us, however, that these substances are present in the resulting mixtures. Now if similar amounts of salt or sugar are placed in such liquids as alcohol or carbon tetrachloride, much less of the solid disappears. How can such results be explained?

A popular food is made by adding hot water to a mixture of flavored gelatin powder. Although the mixture is mostly water, when it cools and sets it forms a delicious jelly-like dessert.

Contrary to a popular notion, pure water is a poor conductor of an electric current; dry acids, bases, and salts are just as poor. If a soluble acid, base, or salt is added to the water, it is then a very good conductor.

Thus we see that water and mixtures of water and other chemicals are of tremendous importance both to chemists and to us in every day activities. In this unit we shall study solutions and solution-like mixtures of water and other substances, and we shall learn something of their importance to the chemical processes used in industry and in the home.<sup>8</sup>

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##### Theory of Solutions

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<sup>8</sup>  
 Rawlins and Struble, Chemistry in Action, p. 165.

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#### Criteria for Evaluation of a Unit<sup>9</sup>

##### Theory of Solutions

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal associations of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should

<sup>9</sup>

Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.

be satisfying.

7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupils to originate, plan, and direct the activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if he desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - Twenty Days

Central Theme - Solutions

#### Objectives

##### Theory of Solutions

- A. Knowledge and Understanding of:
  1. Formation of solutions
  2. The ionic theory of solutions
  3. Nature of acids, bases, and salts
  4. Meaning of the colloidal state
- B. Attitude toward:
  1. The importance of solutions to man



2. The nature of solutions
3. Factors affecting the formation of solutions
4. Kinds of solutions
5. Formations of crystals
6. The nature of colloids
7. The importance of colloids to man
8. The preparation of colloids
9. The formation of ions in solution
10. The nature of acids
11. The nature of bases
12. The nature of salts
13. The value of ions in solutions
14. The practical uses of ions in solutions

C. Habit of:

1. Using the knowledge of solutions in everyday occasions
2. Determining the nature of the solute before trying to dissolve it
3. Determining the nature of the solvent before using it
4. Using the knowledge of colloids in everyday occasions
5. Reading articles on colloids and their uses
6. Using the ionic theory to explain why some solutions conduct electricity
7. Pouring acids into water
8. Determining whether a solution is an acid or base
9. Neutralizing acids and bases
10. Using the ionic theory of solutions to explain how chemical electric cells function

Appreciation for:

1. The explanation of formation of solutions
2. The practical uses of solutions
3. Colloids and how they affect man
4. The ionic theory of solutions and its practical uses
5. The nature of acids, bases, and salts
6. Chemistry and its aid to man
7. Scientific work
8. Knowledge gained in studying chemistry
9. Chemical explanation of everyday chemical processes

#### Approaches

#### Theory of Solutions

This unit may be effectively introduced by demonstrating the ammonia fountain, the conductivity of solutions, behavior of indicators in acids, bases, and salts.

#### Study Guide No. I

#### Formations of Solutions

1. Explanation of why drinking water may taste different in different sections of the country
2. Explanation of why distilled water tastes flat like fresh rain water
3. List of the parts of a solution and definition of each
4. List of the different classes of solutions and illustration of each
5. List of the factors that affect the rate of solution
6. Statement of Henry's Law
7. Definition of the terms "dilute" and "concentrated"
8. Description of how to make a 10 per cent solution of a soluble solid
9. Explanation of (a) unsaturated, (b) saturated, and (c) supersaturated

10. Explanation of the use of crystallization in purifying solid substances

References

Rawlins and Struble, Chemistry in action, pp. 165-176.

Ahrens - Bush - Easley, Living Chemistry, pp. 70-77.

Carleton - Carpenter, Chemistry for the New Age, pp. 264-287.

Subject Matter No. I

Formation of Solutions

- I. Parts of a solution
  - A. Solute
  - B. Solvent
- II. Classes of solutions
  - A. Gases in gases
  - B. Gases in liquids
  - C. Solids in liquids
  - D. Solids in solids
  - E. Liquids in liquids
  - F. Liquids in solids
- III. Definition of solution
- IV. Factors affecting rate of solution
  - A. Size of particle
  - B. Movement
  - C. Temperature
  - D. Pressure
- V. Kinds of solutions
  - A. Dilute
  - B. Concentrated
  - C. Unsaturated

- D. Saturated
- E. Supersaturated

#### VI. Crystallization

- A. Factors affecting
- B. Uses of

### Activities No. I

#### Formations of Solutions

- I. Performing an experiment to show the effects of temperature, size of particle, stirring upon the rate of solution
- II. Performing an experiment to show a supersaturated solution
- III. Performing an experiment to show how crystals are formed

### Correlations No. I

#### Formation of Solutions

Reading - Reading specific references

Spelling - New terms such as: saturated, supersaturated, concentration, solute, solvent

English - Meaning of new terms such as: solution, solute, solvent, saturated, supersaturated, concentration

### Work Sheet No. I

#### Formation of Solutions

Complete the following statements

1. List the two parts of a solution, a. \_\_\_\_\_, b. \_\_\_\_\_.
2. Three factors that affect the rate of solution are, a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
3. A \_\_\_\_\_ is a uniform molecular or ionic mixture of solvent and solute.
4. A \_\_\_\_\_ solution contains more solute than normal for that temperature.

5. A \_\_\_\_\_ is the substance being dissolved.

Mark the following statements true or false using the plus (+) for true and zero (0) for false.

- \_\_\_\_\_ 1. Drinking water has a taste because of the minerals dissolved in it.
- \_\_\_\_\_ 2. The solvent is the substance that is being dissolved.
- \_\_\_\_\_ 3. Solutions can only be made between a solid and a liquid.
- \_\_\_\_\_ 4. All substances dissolve equally as well in water.
- \_\_\_\_\_ 5. Dissolving of some substances can be hastened by heating the solvent.
- \_\_\_\_\_ 6. The solute is the substance into which another is being dissolved.
- \_\_\_\_\_ 7. Lump sugar will dissolve as rapidly as granulated sugar.
- \_\_\_\_\_ 8. Most oxides are insoluble in water.
- \_\_\_\_\_ 9. Increasing the temperature of the solvent decreases the solubility of most gases.
- \_\_\_\_\_ 10. A saturated solution has all the solute molecules it can hold at that temperature.
- \_\_\_\_\_ 11. Crystallization occurs when a solution contains an excess of solute particles above the limit of solubility.
- \_\_\_\_\_ 12. A supersaturated solution contains an excess of solute at a given temperature.
- \_\_\_\_\_ 13. To supersaturate a solution we must saturate it at one temperature and cool it to a lower one.
- \_\_\_\_\_ 14. Curling the hair is an example of a solution of a liquid in a solid.
- \_\_\_\_\_ 15. Increasing the pressure on a liquid increases the solubility of a gas.

- \_\_\_\_ 16. "Coke" is an example of a solution of a gas in a liquid
- \_\_\_\_ 17. Decreasing the pressure on "Coke" causes it to "fizz".
- \_\_\_\_ 18. Stirring of a solution increases the solubility of the solute.
- \_\_\_\_ 19. The finer a substance is ground the faster it will dissolve.
- \_\_\_\_ 20. Drip ground coffee dissolves faster than regular ground coffee.

#### Key to Work Sheet No. I

#### Formation of Solutions

1. Solute, solvent
2. Size of particle, agitation, temperature
3. Solution
4. Supersaturated
5. Solute

#### True or false

- |      |       |       |
|------|-------|-------|
| 1. + | 8. +  | 15. + |
| 2. 0 | 9. +  | 16. + |
| 3. 0 | 10. + | 17. + |
| 4. 0 | 11. + | 18. 0 |
| 5. + | 12. + | 19. + |
| 6. 0 | 13. + | 20. + |
| 7. 0 | 14. + |       |

#### Study Guide No. II

#### Ionic Theory of Solutions

- A. List of some non-conducting solutions
- B. List of some non-conducting pure liquids
- C. List of some conducting solutions
- D. Statement of Arrhenius's Theory
- E. Showing by atomic structure the difference between an ion and an atom

- F. Discussion of the effect of an electrolyte and non-electrolyte upon the freezing and boiling point
- G. Explanation of a raise in boiling point of a solution
- H. Definition of atom, ion, electrolyte, non-electrolyte, ionization
- I. List of some common ionic solutions

#### References

- Rawlins and Struble, Chemistry in Action, pp. 189-195.  
Holmes, Out of the Test Tube, pp. 70-78.  
Arhens - Bush - Easley, Living Chemistry, pp. 70-78.

#### Subject Matter No. II

#### Ionic Theory of Solutions

#### I. Electrolyte

- A. Definition of
- B. Theory of
  - 1. Arrhenius
  - 2. Ions
    - a. Positive
    - b. Negative
    - c. Structure of
- C. Electrolytic cell
  - 1. Nature of
  - 2. Structure of
  - 3. Action in
- D. Effect on boiling point of water
- E. Effect upon freezing point of water
- F. Modification of theory

#### II. Non-electrolyte

- A. Definition of

- B. Conductor of electricity
- C. Effect upon boiling point of water
- D. Effect upon freezing point of water

#### Activities No. II

##### Ionic Theory of Solutions

- A. Demonstration of the ability of solutions to conduct electricity
- B. Construction of an electrolytic cell
- C. Experiment showing raise in boiling point
- D. Showing of film "Primary Cell". Encyclopaedia Britannica Films, Chicago 6, Illinois

#### Correlations No. II

##### Ionic Theory of Solutions

- A. Reading - Specific references
- B. Art - Drawing an electrolytic cell
- C. Spelling - New terms such as ion, electrolyte, ionization
- D. Writing - Writing up experiments
- E. English - Meaning of new terms such as ion, electrolyte, ionization

#### Work Sheet No. II

##### Ionic Theory of Solutions

Complete the following statements to make them read correctly.

1. The theory of ionization was advanced by \_\_\_\_\_ a Swedish chemist.
2. An \_\_\_\_\_ is a charged atom.
3. \_\_\_\_\_ are those substances which will conduct an electric current when in solution.
4. An ion is an atom that has lost an \_\_\_\_\_ or gained one.
5. Metallic ions are \_\_\_\_\_ charged.



6. In an electrolytic cell the negative ions go to the \_\_\_\_\_ electrode.
7. The dissociation of a substance into ions is called \_\_\_\_\_.
8. A mole of sugar will lower the freezing point of 1000 ml. of  $H_2O$  \_\_\_\_\_ degrees.
9. A mole of sugar will raise the boiling point of 1000 ml. of  $H_2O$  \_\_\_\_\_ degrees.
10. A \_\_\_\_\_ is a substance which when in solution will not conduct an electric current.

Mark the following statements true or false using the plus (+) for true and zero (0) for false.

- \_\_\_\_\_ 1. Pure water will conduct an electric current.
- \_\_\_\_\_ 2. All substances ionize when in solution.
- \_\_\_\_\_ 3. Sugar dissolved in water will conduct an electric current.
- \_\_\_\_\_ 4. All electrolytes conduct electric current equally as well.
- \_\_\_\_\_ 5. Salt dissolved in alcohol will not conduct an electric current.
- \_\_\_\_\_ 6. Some ions may gain a proton and become positively charged.
- \_\_\_\_\_ 7. Metal atoms usually lose electrons.
- \_\_\_\_\_ 8. The anode is the negative pole of an electrolytic cell.
- \_\_\_\_\_ 9. Non-metal atoms usually gain electrons and become negatively charged.
- \_\_\_\_\_ 10. One mole of NaCl will raise the boiling point of 1000 ml.  $H_2O$   $.52^{\circ} C$ .

#### Key to Work Sheet No. II

#### Ionic Theory of Solutions

- |              |                |             |
|--------------|----------------|-------------|
| 1. Arrhenius | 3. Electrolyte | 5. Positive |
| 2. Ion       | 4. Electron    | 6. Positive |

7. Ionization	9. $.52^{\circ}$ C.	
8. $1.86^{\circ}$ C.	10. Non-electrolyte	
True or false		
1. 0	4. 0	7. +
2. 0	5. +	8. 0
3. 0	6. 0	9. +
		10. 0

## Study Guide No. III

## Nature of Acids, Bases, and Salts

- A. List of the properties common to all acids
- B. Distinguishing between acids and bases
- C. Definition of acid, base, and salt
- D. List of the different types of acids and salts
- E. List of the common indicators and their uses
- F. List of the ways that acid strengths are stated
- G. List of the common bases
- H. Description of neutralization
- I. Description of the formation of salts
- J. Description of a normal solution
- K. Description of the titration of solutions
- L. Discussion of the naming of salts

## References

- Rawlins and Struble, Chemistry in Action, pp. 196-207.
- Ahrens - Bush - Easley, Living Chemistry, pp. 93-121.
- Jaffe, New World of Chemistry, pp. 201-222.
- Price - Bruce, Chemistry and Human Affairs, pp. 242-268.

## Subject Matter No. III

## Nature of Acids, Bases, and Salts

## I. Acids

- A. Inorganic acids
  - 1. Sulfuric
  - 2. Hydrochloric
  - 3. Nitric
- B. Action of acids on metals
- C. Use of indicators
- D. Definition of acid
- E. Determination of acid strength
  - 1. Concentrated acids
  - 2. Ionization of acids

## II. Bases

- A. Common bases
- B. Ending of bases
- C. Use of indicators
- D. Naming of bases

## III. Neutralization

- A. Practical uses
- B. Acids on bases
- C. Products
- D. Equations
  - 1. Replacement
  - 2. Direct combination
  - 3. Double decomposition
- E. Normal solutions
  - 1. Replaceable hydrogen

2. Replaceable (OH) radical

F. Titration

1. Uses of
2. Use of burette
3. Use of indicators
4. Calculations

IV. Salts

- A. Formation of
- B. Characteristics of
- C. Naming of

Activities No. III

Nature of Acids, Bases, and Salts

- A. Preparation of an experiment showing characteristics of acids, bases, and salts
- B. Preparation of an experiment on titration
- C. Preparation of a chart showing
  1. Name of acid
  2. Formula of acid
  3. Name of salt of metal sodium
  4. Formula for salt
- D. Completion of question No. 21, page 207, Chemistry in Action by Rawlins and Struble

Correlations No. III

Nature of Acids, Bases, and Salts

- A. Writing - Writing up experiments
- B. Reading - Specific references
- C. Mathematics - Problems on neutralization

- D. Spelling - New terms such as neutralization, titration, chloride, normal hydroxide
- E. English - Meaning of acid, base, salt, neutralization, normal, titration

## Work Sheet No. III

## Nature of Acids, Bases, and Salts

Complete the following statements to make them read correctly.

- Blue litmus turns to \_\_\_\_\_ in an acid solution.
- Red litmus turns to \_\_\_\_\_ in a base solution.
- Three important industrial inorganic acids are a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
- All acids contain free \_\_\_\_\_ ions in solutions.
- If a solution tastes sour it is probably an \_\_\_\_\_.
- The indicator \_\_\_\_\_ turns pink in a basic solution.
- The strength of an acid solution depends upon the number of \_\_\_\_\_ ions.
- All bases contain the \_\_\_\_\_ radical.
- Bases have a \_\_\_\_\_ taste.
- The combining of a hydrogen ion and a hydroxyl ion is called \_\_\_\_\_.
- When an acid and base react the two new products are a. \_\_\_\_\_, b. \_\_\_\_\_.
- An \_\_\_\_\_ salt still contains a replaceable hydrogen.
- Complete the following reaction equations.
  - $\text{Fe} + \text{HCl} \longrightarrow$
  - $\text{Fe} + \text{S} \longrightarrow$
  - $\text{NaCl} + \text{AgNO}_3 \longrightarrow$
  - $\text{NaOH} + \text{HCl} \longrightarrow$
- The \_\_\_\_\_ is used to titrate an acid and basic solution.

15. If 20 ml. of 0.5N HCl is required to neutralize 25 ml. of NaOH what is the normality of the base solution?
16. The common acid containing the greatest amount of oxygen has its name ending in \_\_\_\_\_.
17. The acid containing one less oxygen atom has its name ending in \_\_\_\_\_.
18. In naming a base the ending of the hydroxal radical is changed from "al" to \_\_\_\_\_.
19. Salts of binary acids have the ending of \_\_\_\_\_ on the non-metal.
20. Salts of ternary acids have the ending of \_\_\_\_\_ on the non-metal.
21. Acids having the ending of "ous" form salts whose names end in \_\_\_\_\_.
22. Complete the following equations
  - a.  $\text{Ca(OH)}_2 + \text{HCl} \longrightarrow$
  - b.  $\text{NH}_4\text{OH} + \text{HNO}_3 \longrightarrow$
  - c.  $\text{Al(OH)}_3 + \text{H}_2\text{SO}_4 \longrightarrow$
  - d.  $\text{Fe(OH)}_3 + \text{HNO}_3 \longrightarrow$

Mark the following statements true or false using the plus (+) for true and the zero (0) for false.

- \_\_\_\_\_ 1. Water is always produced when an acid and base react.
- \_\_\_\_\_ 2. All acids liberate hydrogen when reacting with metals.
- \_\_\_\_\_ 3. Phenolphthalein in an acid solution turns blue.
- \_\_\_\_\_ 4. The strength of an acid depends upon the degree of ionization in the solution.
- \_\_\_\_\_ 5. Most all bases contain a non-metal element and the hydroxal radical.
- \_\_\_\_\_ 6. Bases have a slippery feeling.
- \_\_\_\_\_ 7. Normal salts contain no replaceable hydrogen ions.
- \_\_\_\_\_ 8. Basic salts contain replaceable hydroxal ions.

- \_\_\_\_\_ 9. A normal solution of hydrochloric acid will contain one gram molecular weight of the acid per 1000 ml. of  $H_2O$ .
- \_\_\_\_\_ 10. The salt  $NaCl$  has the ending of "ate" on its name.

## Key to Work Sheet No. III

## Completion

- |                                   |                    |
|-----------------------------------|--------------------|
| 1. Red                            | 7. Hydrogen        |
| 2. Blue                           | 8. Hydroxal        |
| 3. Sulfuric, nitric, hydrochloric | 9. Bitter          |
| 4. Hydrogen                       | 10. Neutralization |
| 5. Acid                           | 11. Salt, water    |
| 6. Phenolphthalein                | 12. Acid           |
13. a.  $Fe + 2HCl \longrightarrow FeCl_2 + H_2$   
 b.  $Fe + S \longrightarrow FeS$   
 c.  $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$   
 d.  $NaOH + HCl \longrightarrow NaCl + H_2O$
- |             |         |
|-------------|---------|
| 14. Burette | 18. ide |
| 15. 10/25   | 19. ide |
| 16. ic      | 20. ate |
| 17. ous     | 21. ite |
22. a.  $Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$   
 b.  $NH_4OH + HNO_3 \longrightarrow NH_4NO_3 + H_2O$   
 c.  $2Al(OH)_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 6H_2O$   
 d.  $Fe(OH)_3 + 3HNO_3 \longrightarrow Fe(NO_3)_3 + 3H_2O$

## True and false

- |      |      |       |
|------|------|-------|
| 1. + | 4. + | 7. +  |
| 2. 0 | 5. 0 | 8. +  |
| 3. 0 | 6. + | 9. 0  |
|      |      | 10. 0 |

## Study Guide No. IV

## Colloids

- A. Listing types of colloidal dispersions
- B. Defining colloid, micron, absorption
- C. Describing Brownian movement, Tyndall effect
- D. Discussing the electric charge on colloid particles
- E. Formation of deltas and colloids
- F. Describing the methods of preparing colloids
- G. Distinguishing between sols and gels
- H. Listing uses made of colloids
- I. Describing dialysis and its uses
- J. Discussing some of the commercial uses of colloids such as:
  - 1. Cottrell Process
  - 2. Electroplating rubber
  - 3. Ore flotation
  - 4. Making of leather

## References

- Foster, The Romance of Chemistry, pp. 323-340.
- Rawlins - Struble, Chemistry in Action, pp. 176-188.
- Price - Bruce, Chemistry and Human Affairs, pp. 408-418.
- Carleton - Carpenter, Chemistry for the New Age, pp. 288-294.

## Subject Matter No. IV

## Colloids

- I. Common colloids
- II. Comparison of colloid particles with molecules
- III. Meaning of
  - A. Dispersed substance
  - B. Dispersing medium



## IV. Types of colloidal dispersions

- A. Solids in gases
- B. Solids in liquids
- C. Liquids in liquids
- D. Liquids in gases

## V. Size of colloid particles

- A. Diameter of
- B. Micron
  - 1. Meaning of
  - 2. Symbol of
  - 3. Millimicron

## VI. Brownian movement

## VII. Tyndall effect

## VIII. Absorption

- A. Meaning of
- B. Uses of
- C. Different from absorption

## IX. Electric charge in colloid particles

- A. Behavior in solution
- B. Precipitation

## X. Preparation of colloids

- A. Condensation method
  - 1. Sulfur in alcohol and water
  - 2. Ferric chloride
- B. Dispersion method
  - 1. Arc process
  - 2. In water
  - 3. Emulsions

- XI. Sols and gels
  - A. Solid in liquid
  - B. Coagulation
- XII. Protective colloids
  - A. Gelatin in ice cream
  - B. India ink
  - C. Graphite in oil
- XIII. Dialysis
  - A. Graham's theory
  - B. Uses of
  - C. Procedure
- XIV. Commercial uses of colloids and their nature
  - A. Cottrell process
    - 1. Uses of
    - 2. Nature of
  - B. Electroplating rubber
  - C. Ore flotation
  - D. Making of leather
- XV. Formation of deltas
- XVI. Meaning colloids

#### Activities No. IV

##### Colloids

- A. Presentation of the film "Colloids" obtainable from the Encyclopaedia Britannica Films, 20 North Wacker Drive, Chicago 6, Illinois
- B. Presentation of the film "Colloid" obtainable from Shell Oil Co., 50 West 50th Street, New York 20, New York
- C. Preparation by students of an experiment for preparing a colloid

## Correlations No. IV

## Colloids

- A. Reading - Specific references
- B. Writing - Preparation of experiments
- C. Spelling - New terms such as colloid, micron, adsorption, dialysis
- D. English - Meaning of new terms such as colloids, micron, adsorption, dialysis

## Work Sheet No. IV

## Colloids

Mark the following statements true or false using the plus (+) for true and the zero (0) for false.

- \_\_\_\_\_ 1. Colloid particles are smaller than molecules.
- \_\_\_\_\_ 2. Smoke is a colloid.
- \_\_\_\_\_ 3. All colloid particles are the same size.
- \_\_\_\_\_ 4. A micron is one millionth of a millimeter in diameter.
- \_\_\_\_\_ 5. Colloid particles will settle out when left alone for a short time.
- \_\_\_\_\_ 6. Colloid particles are constantly in motion.
- \_\_\_\_\_ 7. Colloid particles are too small to be seen under the microscope.
- \_\_\_\_\_ 8. Colloid particles may be seen by reflecting light off them.
- \_\_\_\_\_ 9. In adsorption the particles adhere to surface in their films.
- \_\_\_\_\_ 10. Gas mask adsorb the poisonous gases.
- \_\_\_\_\_ 11. An ink blotter adsorbs the ink.
- \_\_\_\_\_ 12. Some colloid particles carry an electrical charge.
- \_\_\_\_\_ 13. Deltas are formed by the precipitation of colloid particles.
- \_\_\_\_\_ 14. Colloid particles get their electrical charge from absorbing ions.
- \_\_\_\_\_ 15. A liquid solution of gelatine is a gel.

- \_\_\_\_\_ 16. Jelly is a sol of sugar in water.
- \_\_\_\_\_ 17. Soap helps to cleanse the body by forming an emulsion.
- \_\_\_\_\_ 18. Gelatine dessert as served is a sol.
- \_\_\_\_\_ 19. Ice cream is made smooth by adding gelatine to it.
- \_\_\_\_\_ 20. The Cottrell process is used to purify air and keep down dust and smoke.

Complete the following statements to make them read correctly.

21. The two general methods of preparing colloids are a. \_\_\_\_\_,  
b. \_\_\_\_\_.
22. \_\_\_\_\_ is a process whereby the particles cling to the surface in their films.
23. The motion of colloid particles is known as the \_\_\_\_\_ movement.
24. The reflecting of light by colloid particles is known as the \_\_\_\_\_ effect.
25. The \_\_\_\_\_ is the unit used in measuring the size of colloid particles.

#### Key to Work Sheet No. IV

##### Colloids

- |      |       |       |
|------|-------|-------|
| 1. 0 | 8. +  | 15. 0 |
| 2. + | 9. +  | 16. 0 |
| 3. 0 | 10. + | 17. + |
| 4. 0 | 11. 0 | 18. 0 |
| 5. 0 | 12. + | 19. + |
| 6. + | 13. + | 20. + |
| 7. 0 | 14. + |       |

##### Completion

21. Condensation, dispersion
22. Adsorption

23. Brownian

24. Tyndell

25. Micron

## Culminating Activities

## Theory of Solutions

- I. Explanation by students and showing the operation of a gas mask canister
- II. Demonstration by students of the Tyndell effect
- III. Demonstration by students of the principle of dialysis
- IV. Demonstration and explanation by students of the electric conductivity of solutions
- V. Construction and demonstration by students of an ammonia fountain

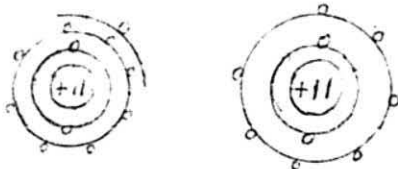
## Desirable Outcomes

## Theory of Solutions

- I. Knowledge and Understanding of:
  - A. Formation of a solution
    1. Parts of a solution
      - a. Solute - The uniformly dispersed substance in the solvent
      - b. Solvent - The dispersing medium
    2. Classes of solution
      - a. Gas in gas - Diffusing of one gas in another
      - b. Gas in liquid - Dispersing of a solid in a liquid
      - c. Solid in liquid - Dissolving of a solid in a liquid
      - d. Solids in solids - A diffusion of one solid into another
      - e. Liquid in liquid - Dissolving of one liquid in another
      - f. Liquid in solid - A diffusion of a liquid in a solid
    3. Definition of solution - A uniform mixture whose composition may vary within wide limits
    4. Factors affecting rate of solution
      - a. Size of particle - The smaller the particle the faster the rate of dissolving

- b. Movement - Increases rate of dissolving
  - c. Temperature
    - (1) Solids
      - (a) More soluble as temperature rises
      - (b) Dissolve faster as temperature rises
    - (2) Gases
      - (a) Less soluble in hot solvent
      - (b) Dissolve more slowly
  - d. Pressure
    - (1) More soluble at high pressure
    - (2) Faster rate at high pressure
  - 5. Kinds of solution
    - a. Dilute
      - (1) A weak solution
      - (2) Made by increasing solvent
    - b. Concentrated
      - (1) A strong solution
      - (2) Made by increasing solute
    - c. Unsaturated - Capable of dissolving more solute
    - d. Saturated - Not capable of dissolving more solute
    - e. Supersaturated
      - (1) Contains more solute than saturated
      - (2) Made by saturating at one temperature there lowering temperature
  - 6. Crystallization - Percipitation of solute in supersaturated solution
- B. Ionic theory of solutions

1. Electrolyte
  - a. A solution
  - b. Will conduct an electric current
  - c. Solute ionizes
2. Developed by Arrhenius
3. Ions - Charged atoms
4. Positive ion - A loss of one or more electrons by an atom
5. Negative ion - A gain of one or more electrons by an atom
6. Structure of
  - a. Sodium atom
  - b. Sodium ion



7. Electrolytic cell
  - a. Contains an electrolyte
  - b. Capable of conducting electricity
  - c. Contains two electrodes
    - (1) Anode - Positive electrode
    - (2) Cathode - Negative electrode
8. Electrolyte
  - a. An electrovalent compound
  - b. Ionizes in solution
  - c. Increases boiling point of water
  - d. Decreases freezing point of water
9. Non - electrolyte
  - a. A covalent compound

- b. Does not ionize
  - c. Will not conduct electric current
  - d. Raises boiling point of 1000 ml. of water  $.52^{\circ}\text{C}$  per gram molecular weight
- C. Nature of acids, bases, and salts
- 1. Acids
    - a. Sulfuric - A water solution of hydrogen sulfate
    - b. Hydrochloric - A water solution of hydrogen chloride
    - c. Nitric - A water solution of hydrogen nitrate
    - d. Action on metals
      - (1) Liberate hydrogen if above hydrogen in electromotive series
      - (2) Form salts
      - (3) Affected by concentration
    - e. Indicators
      - (1) A characteristic color in acid solution
      - (2) Common ones
        - (a) Blue litmus - Red in acid
        - (b) Phenolphthalein - Colorless in acid
    - f. Definition - A solute with free hydrogen ions in solution
    - g. Strength - Depends upon degree of ionization
    - h. Ionization - Produce free hydrogen ions in solution
  - 2. Bases
    - a. Contain free hydroxal ions in solution
    - b. Turns red litmus blue
    - c. Turns phenolphthalein pink
    - d. Named for metal and hydroxal radical



## e. Common bases

- (1) Sodium hydroxide
- (2) Potassium hydroxide
- (3) Ammonium hydroxide
- (4) Calcium hydroxide

## 3. Neutralization

- a. Combining of hydrogen and hydroxal ions
- b. Produces water
- c. Produces salt
- d. Heat of

- (1) Due to chemical activity
- (2) Exothermic - Liberated heat
- (3) Endothermic - Addition of heat

## e. Action of acid upon base

## f. Salts formed

- (1) Neutral - Contains no free hydrogen or hydroxal ions
- (2) Acid - Contains replaceable hydrogen ions
- (3) Basic - Contains replaceable hydroxal ions

## g. Equations

- (1) Displacement - Illustrated  $\text{NaOH} + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$
- (2) Displacement - Illustrated  $\text{Zn} + 2\text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2$
- (3) Double decomposition -  $\text{NaCl} + \text{AgNO}_3 \longrightarrow \text{NaNO}_3 + \text{AgCl}$

## 4. Normal solution - Determined by dividing the gram molecular weight of a substance by the number of replaceable hydrogen or hydroxal ions

## 5. Titration

- a. To determine the strength of acid or base solution

- b. Burette - A graduated tube
- c. Indicators - Denote point of neutralization
- d. Calculations
  - (1) To determine strength of acid or base solution
  - (2) Multiply amount of acid by normality
  - (3) Repeat for base used
  - (4) If equal neutralization

## 6. Salts

- a. Formation of
  - (1) Base and acid neutralization
  - (2) Acid upon metal
  - (3) Reaction of metal upon metal
- b. Characteristics of
  - (1) Normal salt - No free hydrogen or hydroxal ions
  - (2) Acid salt - One or more replacable hydrogen ions
  - (3) Basic salt - One or more replacable hydroxal ions
- c. Naming of
  - (1) Contains name of non-metal and metal
  - (2) Binary acids end in "ide"
  - (3) Ternary acids end in "ate"
  - (4) Acids ending in "ous" end in "ite"

## D. Colloids

- 1. Common ones - Glue, jelly, smoke, fog, milk, protoplasm
- 2. Size of particle - Larger than molecule
- 3. Measured in terms of micron
- 4. Micron
  - a. 1/1000 of a millimeter
  - b. Designated by "u"

5. Movement of particles - Zig-Zag motion
6. Tyndall effect
  - a. Means of viewing particles
  - b. Done by reflected light
7. Dispersed substance - Scattered in dispersing medium
8. Dispersing medium - Contains dispersed substance
9. Adsorption - Clinging of substance to surface of adsorbing medium
10. Charges on particles - Positive or negative
11. Deltas - Precipitation of colloid particles
12. Methods of forming
  - a. Condensation
  - b. Dispersion
13. Sols - Solid in a liquid
14. Gel - Coagulation of a sol
15. Dialysis - Separation of substances by diffusion at different rate through differentially permeable membranes
16. Cottrell Process - Separating smoke particles by means of electrically charged screens
17. Electroplating rubber - Making gloves by plating rubber on a mold
18. Ore flotation - Separating ores from other materials

II. Attitude toward:

- A. Importance of solutions in the life of man
- B. Understanding the relationship of a knowledge of solutions to everyday things
- C. Seeking and acquiring a broader knowledge of chemistry

- D. A knowledge of solutions as an aid to understanding everyday things
- E. Practical uses of the properties of solutions
- F. A knowledge of chemistry as an aid to understanding and reasoning out why things happen as they do

III. Habit of:

- A. Explaining why events happen as they do in terms of chemistry
- B. Planning how to do things before attempting to perform the task
- C. Attempting to predetermine the outcomes before attempting to do a new task
- D. Applying the knowledge of chemistry to daily living
- E. Seeking new knowledge of chemistry
- F. Completing all work started
- G. Observing and understanding new experiences

IV. Appreciation for:

- A. A knowledge of chemistry
- B. An understanding of the nature of solution
- C. Experimental proof of scientific facts
- D. Chemistry and its contributions to the betterment of the standard of living
- E. Development of many new articles by chemistry
- F. Removal of misunderstandings in natural events by chemistry
- G. An understanding that nothing just happens

Leads to Other Units

Theory of Solutions

The student should now understand that the information gained in this unit and past units will help him to understand the following units:



	Ex.	V.G.	G.	F.	P.	None
11. Contain some accurate material?	✓					
12. Provide opportunity to judge, choose, and evaluate?			✓			
13. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?	✓					
14. End lies within available time?		✓				
15. Make it possible for a new teacher to put in practice if she desires?		✓				
16. State clearly where materials may be obtained?		✓				
17. Give complete, exact references?	✓					

## Pupil Test

## Knowledge Test

## Theory of Solutions

Complete the following statements to make them read correctly.

- List the two parts of a solution, a. \_\_\_\_\_,  
b. \_\_\_\_\_.
- A \_\_\_\_\_ is a uniform molecular or ionic mixture of a solvent and solute.
- A \_\_\_\_\_ is the substance being dissolved.
- An \_\_\_\_\_ is a charged atom.
- An ion is an atom that has lost or gained at least one \_\_\_\_\_.

6. In an electrolytic cell the negative ions go to the \_\_\_\_\_ electrode.
7. The \_\_\_\_\_ is the positive charged particle in an atom nucleus.
8. A mole of sugar will lower the freezing point of 500 ml. of  $H_2O$  \_\_\_\_\_ degrees.
9. A \_\_\_\_\_ is a substance which when in solution will not conduct an electric current.
10. Blue litmus turns to \_\_\_\_\_ in an acid solution.
11. Three important industrial inorganic acids are a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
12. All acids contain free \_\_\_\_\_ ions in solution.
13. The indicator \_\_\_\_\_ turns pink in a basic solution.
14. All bases contain the \_\_\_\_\_ radical ion in solution.
15. When an acid and base react the two new products are a. \_\_\_\_\_, b. \_\_\_\_\_.
16. Complete the following reaction equations
  - a.  $Zn + HCl \longrightarrow$
  - b.  $Cu + S \longrightarrow$
  - c.  $BaCl_2 + AgNO_3 \longrightarrow$
  - d.  $KOH + H_2SO_4 \longrightarrow$
17. If 20 ml. of 0.5N HCl is required to neutralize 25 ml. of NaOH, what is the normality of the base solution?
18. The acid containing one less oxygen atom has its name ending in \_\_\_\_\_.
19. Salts of binary acids have the ending of \_\_\_\_\_ on the non-metals.
20. Acids having the ending of "ous" form salts whose names end in \_\_\_\_\_.

21. The two general methods of preparing colloids are a. \_\_\_\_\_,  
b. \_\_\_\_\_.
22. The motion of colloid particles is known as the \_\_\_\_\_.
23. The \_\_\_\_\_ is the unit used in measuring the size of  
colloid particles.
24. A \_\_\_\_\_ is a sol that has solidified.
25. A gas mask purifies the air by \_\_\_\_\_.

Mark the following statements true or false and use the plus (+) sign for true and the zero (0) sign for false.

- \_\_\_\_\_ 1. The solvent is the substance being dissolved in forming a solution.
- \_\_\_\_\_ 2. All substance dissolve equally as fast in water.
- \_\_\_\_\_ 3. Heating of the solvent hastens the dissolving of all solutes.
- \_\_\_\_\_ 4. The smaller the particle of solute the faster it will dissolve in the solvent.
- \_\_\_\_\_ 5. A saturated solution will dissolve more solute if it is stirred.
- \_\_\_\_\_ 6. A supersaturated solution is formed by raising the temperature of the saturated temperature.
- \_\_\_\_\_ 7. Increasing the pressure on a liquid increases the solubility of a gas.
- \_\_\_\_\_ 8. Drip ground coffee dissolves faster than regular ground coffee.
- \_\_\_\_\_ 9. Pure water will conduct an electric current.
- \_\_\_\_\_ 10. Sugar dissolved in water will conduct an electric current.
- \_\_\_\_\_ 11. Some ions may gain a proton and become positively charged.
- \_\_\_\_\_ 12. Metals atoms usually lose electrons.
- \_\_\_\_\_ 13. One mole of Na Cl will raise the boiling point of 1000 ml. of  $H_2O$  .52°C.



- \_\_\_\_ 14. Water is always produced when an acid and base react.
- \_\_\_\_ 15. The strength of an acid depends upon the degree of ionization in solution.
- \_\_\_\_ 16. Bases have a slippery feeling.
- \_\_\_\_ 17. Normal salts contain no replaceable hydrogen ions.
- \_\_\_\_ 18. The salt NaCl has the ending of "ate" on its name.
- \_\_\_\_ 19. Colloid particles are smaller than molecules.
- \_\_\_\_ 20. Smoke is a colloid.
- \_\_\_\_ 21. Colloid particles will settle out when left alone for a short time.
- \_\_\_\_ 22. In adsorption the particles adhere to surfaces in thin films.
- \_\_\_\_ 23. An ink blotter adsorbs the ink.
- \_\_\_\_ 24. A liquid solution of gelatin is a gel.
- \_\_\_\_ 25. Ice cream is made smooth by adding gelatine to it.

### Key to Knowledge Test

#### Theory of Solutions

##### Completion

- |   |                                     |
|---|-------------------------------------|
| 1. Solute, solvent  | 8. $.93^{\circ}\text{C}$            |
| 2. Solution   | 9. Non-electrolyte                  |
| 3. Solute   | 10. Red                             |
| 4. Ion  | 11. Hydrochloric, Nitric, Sulphuric |
| 5. Electron   | 12. Hydrogen                        |
| 6. Anode  | 13. Phenolphthalein                 |
| 7. Proton   | 14. Hydroxal                        |
| 16. (a) $\text{Zn} + 2\text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2$                          | 15. Salt and water                  |
| (b) $\text{Cu} + \text{S} \longrightarrow \text{CuS}$   |                                     |
| (c) $\text{BaCl}_2 + 2\text{AgNO}_3 \longrightarrow 2\text{AgCl} + \text{Ba}(\text{NO}_3)_2$          |                                     |
| (d) $2\text{KOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$ |                                     |

- |                              |                       |
|------------------------------|-----------------------|
| 17. .4 N                     | 22. Brownian movement |
| 18. "ous"                    | 23. Micron            |
| 19. "ide"                    | 24. Gel               |
| 20. "ite"                    | 25. Adsorbing         |
| 21. Condensation, dispersion |                       |

True or false

- |      |       |       |
|------|-------|-------|
| 1. 0 | 9. 0  | 17. + |
| 2. 0 | 10. 0 | 18. 0 |
| 3. 0 | 11. 0 | 19. 0 |
| 4. + | 12. + | 20. + |
| 5. 0 | 13. 0 | 21. + |
| 6. 0 | 14. + | 22. + |
| 7. + | 15. + | 23. 0 |
| 8. + | 16. + | 24. 0 |
|      |       | 25. + |

#### Pupil Test

#### Attitude Test

#### Theory of Solutions

Write yes or no to the left of each statement.

- \_\_\_\_\_ 1. Do you read scientific news items in daily newspapers?
- \_\_\_\_\_ 2. Do you seek the explanation of why a certain event happened?
- \_\_\_\_\_ 3. Do you plan your experiments before attempting to perform them?
- \_\_\_\_\_ 4. Do you feel that the study of solutions has helped you?
- \_\_\_\_\_ 5. Do you explain everyday things in scientific terms were possible?
- \_\_\_\_\_ 6. Do you read more material than the teacher assigns to you?
- \_\_\_\_\_ 7. Do you perform all experiments as completely as possible?
- \_\_\_\_\_ 8. Do you like to perform experiments?

- \_\_\_\_\_ 9. Do you keep all equipment clean?
- \_\_\_\_\_ 10. Do you feel that you understand the materials in this unit enough to go on into the next unit?

## Pupil Test

## Habit Test

## Theory of Solutions

Check the desirable statements.

- \_\_\_\_\_ 1. I understand what I am to do before doing it.
- \_\_\_\_\_ 2. I perform an experiment before I have read it completely.
- \_\_\_\_\_ 3. I prepare all daily assignments on the day they are assigned.
- \_\_\_\_\_ 4. I attempt to understand why an event happened.
- \_\_\_\_\_ 5. I read only what is assigned to me.
- \_\_\_\_\_ 6. I attempt to find practical applications of my knowledge of chemistry.
- \_\_\_\_\_ 7. I don't see how chemistry has helped me and never will.
- \_\_\_\_\_ 8. I have developed an inquisitive mind.
- \_\_\_\_\_ 9. I have a set time and place to study chemistry.
- \_\_\_\_\_ 10. I like to perform exact procedures.

## Key to Habit Test

## Theory of Solutions

A desirable answer would be a check for all statements except Nos. 2, 5, 7.

## Pupil Test

## Appreciation Test

## Theory of Solutions

Write yes or no before each statement.

- \_\_\_\_\_ 1. I appreciate how the knowledge of chemistry helps me to understand events.

- \_\_\_\_\_ 2. I appreciate the experiment and how it helps me to understand the principles of chemistry.
- \_\_\_\_\_ 3. I appreciate scientific news items in daily newspapers.
- \_\_\_\_\_ 4. I appreciate the field of chemistry and how it has improved daily living.
- \_\_\_\_\_ 5. I appreciate the opportunity to study chemistry in an organized group.
- \_\_\_\_\_ 6. I am satisfied with the type of work I am doing in chemistry.
- \_\_\_\_\_ 7. I appreciate the equipment provided for me in the laboratory.
- \_\_\_\_\_ 8. I take good care of the equipment provided me.
- \_\_\_\_\_ 9. I appreciate the knowledge of solutions and its help to me.
- \_\_\_\_\_ 10. I appreciate the opportunity to do my own individual work in the laboratory.

#### Key to Appreciation Test

##### Theory of Solutions

A desirable answer would be yes to all except number 6.

##### Bibliography

##### Theory of Solutions

##### Teacher

- Rawlins - Struble, Chemistry in Action, (D. C. Heath and Co., Boston, Mass., 1948).
- Holmes, Harry N., Out of the Test Tube, (Emerson Book, Inc., New York, 1943).
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#### Pupil

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Ahrens - Bush - Easley, Living Chemistry, (Ginn and Company, Chicago, Ill., 1949).

Carleton - Carpenter, Chemistry for the New Age, (J. B. Lippincott Company, Chicago, Ill., 1949).

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#### Unit V

##### Nitrogen and Its Compounds

No element is more important to man than nitrogen. It is, however, the most abundant "gas" of the earth; it makes up 78 per cent of the atmosphere.

As an element, nitrogen is quite inactive, combining with only a few other elements directly and then only at high temperatures or in the presence of special catalysts such as may be found in certain bacteria.<sup>10</sup>

When with great care we build up nitrogen compounds, we find that they tend to go to pieces suddenly, like a house of cards. They are our

<sup>10</sup>

Rawlins - Struble, Chemistry in Action, p. 223.

high explosives.<sup>11</sup>

But more important still, there is nitrogen in every molecule of protein, an essential part of all plant and animal protoplasm. It is the nitrogen compounds in the soil which are utilized by plants to make this protein.

As you study further you will learn more about this indispensable element.

#### Table of Contents for Unit No. V

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McPherson - Henderson - Fowler, Chemistry at Work, p. 265.

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#### Criteria for Evaluation of a Unit <sup>12</sup>

##### Nitrogen and Its Compounds

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal association of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.

<sup>12</sup>

Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.



7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupil to originate, plan, and direct the activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - Ten Days

Central Theme - The Indispensable Element

#### Objectives

#### Nitrogen and Its Compounds

##### A. Knowledge and Understanding of:

1. Importance of nitrogen to life
2. Sources and uses of ammonia
3. Preparation and uses of nitric acid
4. Manufacture and uses of explosives

##### B. Attitude toward:

1. Importance of nitrogen to life
2. The aid of chemistry in understanding life processes

3. A better appreciation of things about us through chemistry
4. Importance of nitrogen compounds to man
5. Explaining and understanding things through chemistry

C. Habit of:

1. Developing a continuous study program
2. Developing good study habits in chemistry
3. Using scientific knowledge in explaining many things that are found in daily living
4. Seeking out and reading scientific information in current literature
5. Developing good living habits

D. Appreciation for:

1. An understanding of importance of nitrogen to life
2. The benefits of nitrogen in developing our high standard of living
3. Scientific knowledge
4. Experimental evidence in studying chemistry
5. Chemistry and its contributions to the prevention and cure of diseases

### Approaches

#### Nitrogen and Its Compounds

This unit may be effectively introduced by demonstrating the ammonia fountain; demonstrating the use of ammonia in cleaning grease from glass, action of nitric acid upon a penny.

#### Study Guide No. I

#### The Element, Nitrogen

- A. Listing the places that nitrogen may be found

- B. Listing some of the properties of nitrogen
- C. Listing some of the uses of nitrogen
- D. Discussion of the preparation of nitrogen
- E. Writing equations for these preparations
- F. Describing how bacteria aid in making nitrogen compounds in nature
- G. Diagraming the nitrogen cycle in nature
- H. Describing how nitrogen fixing aids man

#### References

- Rawlins - Struble, Chemistry in Action, pp. 223-232.
- Price - Bruce, Chemistry and Human Affairs, pp. 348-353.

#### Subject Matter No. I

#### The Element, Nitrogen

- I. Sources of nitrogen
  - A. Air
  - B. Living matter
  - C. Coal
  - D. Earth's surface
- II. Properties of nitrogen
  - A. Physical
  - B. Chemical
- III. Uses of nitrogen
  - A. Making of nitrates
  - B. Medicines
  - C. Proteins
  - D. Plastics
  - E. Glue

#### IV. Preparation of nitrogen

- A. Air over hot copper
- B. Laboratory method
  - 1. Burning phosphorus in air
  - 2. Sodium nitrite and
- C. Commercial - Fractional distillation of air

#### V. Nitrogen fixation

- A. Meaning of
- B. Methods
  - 1. Lightning
  - 2. Arc process
  - 3. Bacteria
    - a. Azotobacter
    - b. Rhizopus
    - c. Nitrosomonas
    - d. Nitrobacter

#### Activities No. I

##### The Element, Nitrogen

- A. Preparation of nitrogen in the laboratory
- B. Showing the film "Atacama Desert," Associations Films, 347 Madison Avenue, New York 17, New York
- C. Answering questions on pages 233-34, Chemistry in Action, Rawlins - Struble

#### Correlations No. I

##### The Element, Nitrogen

- A. Reading - Specific references
- B. Writing - Laboratory experiments

- C. Spelling - New terms such as: uria, azotobacter, rhizopus, nitrosomonas, nitrobacter

Work Sheet No. I

The Element, Nitrogen

Mark the following statements true or false using the plus (+) sign for true and the zero (0) for false.

- \_\_\_\_\_ 1. 20% of the air is nitrogen.
- \_\_\_\_\_ 2. All animal proteins contain nitrogen.
- \_\_\_\_\_ 3. Nitrogen compounds are produced in making coke.
- \_\_\_\_\_ 4. Chile saltpeter is a compound of nitrogen.
- \_\_\_\_\_ 5. Nitrogen has a pungent odor.
- \_\_\_\_\_ 6. Nitrogen burns easily in the presence of oxygen.
- \_\_\_\_\_ 7. Ammonia has the formula  $\text{NH}_3$ .
- \_\_\_\_\_ 8. Nitrogen does not react easily and must be put under pressure.
- \_\_\_\_\_ 9. Nitric acid is an important compound of nitrogen.
- \_\_\_\_\_ 10. Nylon contains nitrogen.
- \_\_\_\_\_ 11. Urea is a nitrogen compound excreted by the human body.
- \_\_\_\_\_ 12. Urea is used in making plastics.
- \_\_\_\_\_ 13. To prevent lumber from cracking, urea is coated on the lumber.
- \_\_\_\_\_ 14. Glue containing urea easily dissolves in water.
- \_\_\_\_\_ 15. Pure nitrogen may be prepared by heating copper oxide in air.
- \_\_\_\_\_ 16. Phosphorus burns in air to form phosphorus pentoxide.
- \_\_\_\_\_ 17. Nitrogen is very soluble in water.
- \_\_\_\_\_ 18. Ammonium nitrite decomposes into nitrogen and water.
- \_\_\_\_\_ 19. The formula for nitric acid is  $\text{HNO}_2$ .
- \_\_\_\_\_ 20. Legume plants are capable of making nitrogen compounds.
- \_\_\_\_\_ 21. Rhizopus live in free soil and form nitrates from free nitrogen and oxygen.

- \_\_\_\_ 22. Alfalfa is a legume plant.
- \_\_\_\_ 23. Nitrobacter bacteria changes nitrites into nitrates.
- \_\_\_\_ 24. Nitrogen is necessary for living organisms.
- \_\_\_\_ 25. Some bacteria are capable of changing nitrogen compounds into free nitrogen.

## Key to Work Sheet No. I

## The Element, Nitrogen

1. 0	10. +	18. +
2. +	11. +	19. 0
3. +	12. +	20. 0
4. +	13. +	21. 0
5. 0	14. 0	22. +
6. 0	15. 0	23. +
7. +	16. +	24. +
8. +	17. 0	25. +
9. +		

## Study Guide No. II

## Ammonia

- A. Preparation of ammonia in the laboratory
- B. Preparation of ammonia commercially
- C. Listing the uses made of ammonia
- D. Listing some of the properties of ammonia
- E. Sources of nitrogen and hydrogen

## References

- Rawlins - Struble, Chemistry in Action, pp. 233-239.
- Price - Bruce, Chemistry and Human Affairs, pp. 355-359.
- Foster, The Romance of Chemistry, pp. 194-199.

Holmes, Out of the Test Tube, pp. 168-177.

Subject Matter No. II

Ammonia

- I. Preparation of ammonia
  - A. Laboratory - Ammonia salt and weak base
  - B. Commercial
    - 1. Haber process
    - 2. Cyanamide process
    - 3. Sources of
      - a. Hydrogen
      - b. Nitrogen
- II. Properties of ammonia
  - A. Physical
  - B. Chemical
- III. Uses of ammonia and ammonium salts

Activities No. II

Ammonia

- A. Preparation of ammonia in the laboratory
- B. Solving problems on page 239, Rawlings - Struble, Chemistry in Action

Correlations No. II

Ammonia

- A. Reading - Specific reference
- B. Spelling - New terms in subject matter such as: ammonia, cyanamide, ammonium hydroxide, Haber process
- C. Writing - Experiments performed in the laboratory

## Work Sheet No. XI

## Ammonia

Complete the following statements:

1. Ammonia was prepared in the laboratory by heating a mixture of \_\_\_\_\_ and \_\_\_\_\_.
2. Ammonia dissolves in water to form \_\_\_\_\_.
3. The chemical formula of ammonia is \_\_\_\_\_.
4. The chemical formula for ammonium hydroxide is \_\_\_\_\_.
5. Ammonia contains the two elements \_\_\_\_\_ and \_\_\_\_\_.
6. Ammonia is prepared commercially mainly by the \_\_\_\_\_ process.
7. Calcium \_\_\_\_\_ reacts with water to form ammonia and calcium carbonate.
8. Give two commercial uses of ammonia a. \_\_\_\_\_,  
b. \_\_\_\_\_.

Mark the following statements true or false using the (+) sign for true and the (0) for false.

- \_\_\_\_\_ 1. Ammonia is only slightly soluble in water.
- \_\_\_\_\_ 2. Ammonium hydroxide is unstable.
- \_\_\_\_\_ 3. Ammonia contains three times as much hydrogen as nitrogen by volume.
- \_\_\_\_\_ 4. Phenolphthalein will turn pink in a solution of ammonia.
- \_\_\_\_\_ 5. Hydrogen used in making ammonia is secured from the air.
- \_\_\_\_\_ 6. Nitrogen used in making ammonia is secured by passing steam over hot coke.
- \_\_\_\_\_ 7. Ammonia gas is easily compressed.
- \_\_\_\_\_ 8. Household ammonia contains ammonium hydroxide.
- \_\_\_\_\_ 9. Smelling salts sometimes contains ammonium carbonate.



10. Ammonia has a pungent odor.

### Key to Work Sheet No. II

#### Completion

#### Ammonia

1. Ammonium chloride and calcium hydroxide
2. Ammonium hydroxide
3.  $\text{NH}_3$
4.  $\text{NH}_4\text{OH}$
5. Nitrogen and hydrogen
6. Haber
7. Cyananide
8. a. Making household ammonia  
b. Making of explosives

#### True or false

- |      |       |
|------|-------|
| 1. 0 | 6. 0  |
| 2. + | 7. +  |
| 3. + | 8. +  |
| 4. + | 9. +  |
| 5. 0 | 10. + |

### Study Guide No. III

#### Nitric Acid

- A. Discussion of the preparation of nitric acid in the laboratory
- B. Commercial preparation of nitric acid
- C. Description of the action of nitric acid upon copper
- D. Definition of oxidation and reduction in terms of volume
- E. Writing equations to show volume changes when (a) hydrogen reduces copper oxide, (b) Nitric acid acts on copper
- F. Accounting for the action of aqua regia

- G. Description of the test for nitrates
- H. Listing the uses of nitric acid
- I. Description of laughing gas
- J. Discussion of the oxides of nitrogen

#### References

- Rawlins - Struble, Chemistry in Action, pp. 238-245.  
 Joffe, New World of Chemistry, pp. 268-280.  
 Foster, The Romance of Chemistry, pp. 194-197.

#### Subject Matter No. III

#### Nitric Acid

#### I. Preparation of

- A. Laboratory - Sodium nitrate and sulfuric acid
- B. Commercial - Oxidation of ammonia

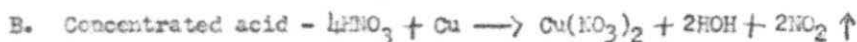
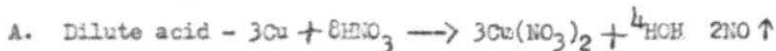
#### C. Equations



#### II. Properties of

- A. Physical
- B. Chemical
  - 1. Corrosive
  - 2. Oxidizing agent

#### III. Action on copper



## IV. Reduction and oxidation

- A. Reduction the gain in electrons and a decrease of positive valence of an element
- B. Oxidation the loss in electrons and a gain in positive valence of an element
- C. Reduction of Cu O

## V. Aqua regia

- A. Composition
- B. Reaction -  $3\text{HCl} + \text{HNO}_3 \longrightarrow 2\text{HOH} + \text{NO} \uparrow + 3 [\text{Cl}]$

## VI. Nitrate test

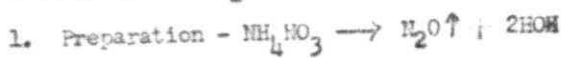
- A. Compounds used
- B. Results

## VII. Uses of nitric acid

- A. Test for proteins
- B. Commercial

## VIII. Oxides of nitrogen

- A. Nitric Oxide - NO
- B. Nitrogen dioxide -  $\text{NO}_2$
- C. Nitrous oxide -  $\text{N}_2\text{O}$



- 2. Uses of

## Activities No. III

## Nitric Acid

- A. Preparation of nitric acid in the laboratory
- B. Demonstration of the action of dilute and concentrated nitric acid upon copper
- C. Performing the Brown ring test for nitrates in the laboratory

## D. Preparing nitric oxide in the laboratory

## Correlations No. III

## Nitric Acid

- A. Reading - Specific references
- B. Writing - Writing up experiments performed in the laboratory
- C. Art - Diagrams showing equipment set up in laboratory experiments
- D. Spelling - New terms found in subject matter such as: aqua regia,  
nitric oxide, nitrous oxide

## Work Sheet No. III

## Nitric Acid

Complete the following statements to make them read correctly:

1. \_\_\_\_\_ and \_\_\_\_\_ were used in the laboratory to prepare nitric acid.
2. The formula for nitric acid is \_\_\_\_\_.
3. Write the equation to show the decomposition of nitric acid in the reagent bottle. \_\_\_\_\_.
4. Write the equation to show the action of dilute nitric acid upon copper. \_\_\_\_\_.
5. Write the equation to show the action of concentrated nitric acid upon copper. \_\_\_\_\_.
6. \_\_\_\_\_ is the gain in electrons and a loss in positive valence of an element.
7. \_\_\_\_\_ is the loss of electrons and a gain in positive valence of an element.
8. Write an equation to show the electron exchange involved in the action of steam upon copper oxide. \_\_\_\_\_.
9. The \_\_\_\_\_ test is used to determine the pressure of

nitrate in a compound.

10. Give the formula for the following:

- a. Nitrous oxide \_\_\_\_\_.
- b. Nitric oxide \_\_\_\_\_.
- c. Nitrogen dioxide \_\_\_\_\_.

Mark the following statements with a plus (+) for the true and a zero (0) for the false.

- \_\_\_\_\_ 1. Nitric acid is a strong oxidizing agent.
- \_\_\_\_\_ 2. Nitric acid is prepared by oxidizing ammonia.
- \_\_\_\_\_ 3. Nitric acid is corrosive in its action.
- \_\_\_\_\_ 4. When nitric oxide is dissolved in water, nitric acid is formed.
- \_\_\_\_\_ 5. In the reduction of copper oxide with nitric acid, the copper gains electrons.
- \_\_\_\_\_ 6. Sulfuric acid is used in the test for nitrates.
- \_\_\_\_\_ 7. Nitric acid will react with gold to produce a salt.
- \_\_\_\_\_ 8. Nitric acid reacts upon all metals to produce free hydrogen.
- \_\_\_\_\_ 9. Egg white turns yellow in the presence of nitric acid.
- \_\_\_\_\_ 10. "Laughing gas" is nitric oxide.
- \_\_\_\_\_ 11. "Laughing gas" was used as an anesthetic.
- \_\_\_\_\_ 12. Nitrous oxide is made by heating ammonium nitrate.
- \_\_\_\_\_ 13. Nitrogen dioxide is a colorless gas.
- \_\_\_\_\_ 14. Nitrogen dioxide is a poisonous gas.
- \_\_\_\_\_ 15. Nitric oxide will support the combustion of phosphorus.

## Key to Work Sheet No. III

## Nitric Acid

## Completion

1. Sodium nitrate and sulfuric acid
2.  $\text{HNO}_3$
3.  $4\text{HNO}_3 \longrightarrow 2\text{H}_2\text{O} + 4\text{NO}_2 \uparrow + \text{O}_2 \uparrow$
4.  $3\text{Cu} + 8\text{HNO}_3 \longrightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{HOH} + 2\text{NO} \uparrow$
5.  $4\text{HNO}_3 + \text{Cu} \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{HOH} + 2\text{NO}_2 \uparrow$
6. Reduction
7. Oxidation
8.  $\text{CuO} + \text{H}_2^\circ \longrightarrow \text{Cu}^\circ + \text{HOH}$   
 $\text{Cu} + 2\text{e} \longrightarrow \text{Cu}^\circ$   
 $\text{H}_2^\circ + 2\text{e} \longrightarrow 2\text{H}$
9. Brown ring
10. a.  $\text{H}_2\text{O}$  ; b.  $\text{NO}$  ; c.  $\text{NO}_2$

## True and false

- |      |       |       |
|------|-------|-------|
| 1. + | 6. +  | 11. + |
| 2. + | 7. 0  | 12. + |
| 3. + | 8. 0  | 13. 0 |
| 4. 0 | 9. +  | 14. + |
| 5. + | 10. 0 | 15. + |

## Study Guide No. IV

## Explosives

Completion of the questions on page 251 of Rawlins - Struble, Chemistry in Action

## References

Rawlins - Struble, Chemistry in Action, pp. 246-251

## Subject Matter No. IV

## Explosives

- I. Uses of explosives
  - A. Peace time
  - B. War
  - C. Time known to man
- II. Comparison of
  - A. Combustion
  - B. Detonation
- III. Types of explosives
  - A. Dynamite
    - 1. Composition
    - 2. Explosive action
  - B. Guncotton
    - 1. Preparation of
    - 2. Cellulose
    - 3. Pyroxylin
      - a. Composition
      - b. Uses
  - C. Smokeless powder
    - 1. Preparation of
    - 2. Uses of
- IV. Explosive shells
  - A. Detonators
  - B. Boosters
  - C. High explosives
  - D. Propellants

## E. Bombs

## Activities No. IV

## Explosives

Preparation of a short report on explosives and their uses

## Correlations No. IV

## Explosives

- A. Reading - Specific references
- B. Spelling - New terms found in subject matter such as: nitroglycerin, cellulose, pyroxylin, demolition, fragmentation, detonators, trinitrotoluene

## Work Sheet No. IV

## Explosives

Mark the following statements with a plus (+) for true and a zero (0) for false.

- \_\_\_\_\_ 1. The Chinese were the first to use explosives.
- \_\_\_\_\_ 2. Explosives were used first in the making of firecrackers.
- \_\_\_\_\_ 3. Slow explosives such as dynamite burn at a slow uniform rate.
- \_\_\_\_\_ 4. Detonation is a sudden explosion.
- \_\_\_\_\_ 5. Detonating explosives are used in propellants.
- \_\_\_\_\_ 6. To do damage explosives must be placed in a confined place.
- \_\_\_\_\_ 7. Dynamite contains the explosive trinitrotoluene.
- \_\_\_\_\_ 8. Wood pulp is used in dynamite to make it safe to handle.
- \_\_\_\_\_ 9. Nitroglycerin is dangerous to handle because a "jar" may set it off.
- \_\_\_\_\_ 10. Nitrocellulose is commonly called guncotton.
- \_\_\_\_\_ 11. Cotton is used in making nitrocellulose.
- \_\_\_\_\_ 12. Nitrocellulose is made by the action of nitric acid on cellulose.



- \_\_\_\_ 13. Pyroxylin is used in making celluloid.
- \_\_\_\_ 14. Motion picture film made by pyroxylin is fireproof.
- \_\_\_\_ 15. Detonators enable a shell to explode after hitting the object or just before.
- \_\_\_\_ 16. Trinitrotoluene must be set off by use of a booster.
- \_\_\_\_ 17. Propellents must be made of slow burning explosives.
- \_\_\_\_ 18. Demolition bombs are guided by fins.
- \_\_\_\_ 19. Fragmentation bombs contain steel scrap to do damage when the bomb explodes.
- \_\_\_\_ 20. Cordite is a propellant.

#### Key to Work Sheet No. IV

##### Explosives

1. +	6. 0	11. +	16. +
2. +	7. 0	12. +	17. +
3. 0	8. +	13. +	18. +
4. +	9. +	14. 0	19. +
5. 0	10. +	15. +	20. +

##### Culminating Activities

##### Nitrogen and Its Compounds

- I. Preparation of a report upon rockets as to their construction, fuels used, uses of
- II. Preparation of a chart showing the variety of uses of ammonia
- III. Preparation of a chart showing the nitrogen cycle
- IV. Presentation of the film "Chilean Nitrates" - Hollywood Film Enterprises, 6060 Sunset Blvd., Hollywood 28, California

## Desirable Outcomes

## Nitrogen and Its Compounds

## I. Knowledge and Understanding of:

## A. The element, nitrogen

1. Makes up  $\frac{4}{5}$  of the atmosphere
2. Found in proteins
3. A colorless, odorless gas
4. Slightly soluble in water
5. Neither burns nor supports combustion
6. Used in making nitric acid and ammonia
7. Found in urea, a waste product of the metabolism of proteins
8. Obtained from the air by passing air over hot copper
9. Obtained in laboratory by burning phosphorus in a jar of air
10. Equation -  $4P + 5O_2 \longrightarrow 2P_2O_5$
11. Obtained in pure form by heating a mixture of ammonium chloride and sodium nitrite
12. Equation -  $NH_4Cl + NaNO_2 \longrightarrow NaCl + NH_4NO_2$   
 $NH_4NO_2 \longrightarrow 2H_2O + N_2 \uparrow$
13. Nitrogen fixation - The combining of nitrogen with other elements

a. Lightning -  $N_2 + O_2 \longrightarrow 2NO$ 

## b. Arc process - Blowing nitrogen into an electric arc

## c. Bacteria

(1) Changing of free nitrogen into nitrates by azotobacter

(2) Living of rhizopus in legume plants

(3) Legume plants - Plants with bacteria in the roots which are capable of making nitrates

(4) Changing of ammonia into nitrates by nitrosomonas bacteria

(5) Changing of nitrites into nitrates by nitrobacter bacteria

#### B. Ammonia

1. Preparation in the laboratory by heating ammonium chloride and calcium hydroxide together
2. Equation -  $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{NH}_4\text{OH}$   
 $2\text{NH}_4\text{OH} \longrightarrow 2\text{NH}_3\uparrow + 2\text{H}_2\text{O}$
3. A colorless, pungent gas
4. Very soluble in water
5. Equation -  $\text{NH}_3 + \text{H}_2\text{O} \longrightarrow \text{NH}_4\text{OH}$
6. Contains three atoms of hydrogen and one of nitrogen
7. Formula -  $\text{NH}_3$
8. Liquifying air and fractional distillation a source of nitrogen
9. Fuel gas - Source of hydrogen
10. Cyanamide process - Reaction of calcium cyanamide with water
11. Equation -  $\text{CaCN}_2 + 3\text{H}_2\text{O} \longrightarrow 2\text{NH}_3\uparrow + \text{CaCO}_3$
12. Used in making
  - a. Compounds of ammonia
  - b. Explosives, dyes, drugs, etc

#### C. Nitric Acid

1. Preparation in the laboratory by heating sodium nitrate and sulfuric acid

2. Equation -  $\text{NaNO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{NaHSO}_4 + \text{HNO}_3 \uparrow$
3. Made commercially by oxidizing ammonia
4. Equations -  $4\text{NH}_3 + 5\text{O}_2 \longrightarrow 4\text{NO} \uparrow + 6\text{H}_2\text{O}$   
 $2\text{NO} + \text{O}_2 \longrightarrow 2\text{NO}_2 \uparrow$   
 $3\text{NO}_2 + \text{H}_2\text{O} \longrightarrow 2\text{HNO}_3 + \text{NO} \uparrow$
5. Colorless, fuming liquid
6. Decomposes into water and nitrogen dioxide and oxygen
7. Equation -  $4\text{HNO}_3 \longrightarrow 2\text{H}_2\text{O} + 4\text{NO}_2 \uparrow + \text{O}_2 \uparrow$
8. Highly corrosive
9. A good oxidizing agent
10. Action of dilute acid on copper  
 $3\text{Cu} + 8\text{HNO}_3 \longrightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} + 2\text{NO} \uparrow$
11. Action of concentration acid on copper  
 $4\text{HNO}_3 + \text{Cu} \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2 \uparrow$
12. Reduction - A gain of electrons and a loss of positive valence
13. Oxidation - A loss of electrons and a gain in positive valence
14. Aqua regia
  - a. Mixture of nitric acid and hydrochloric acid
  - b. Will act on the noble metals gold, silver, etc
  - c. Equation -  $3\text{HCl} + \text{HNO}_3 \longrightarrow 2\text{H}_2\text{O} + \text{NO} \uparrow + 3[\text{Cl}] \uparrow$
  - d. Action due to nascent chlorine
15. Test for nitrates
  - a. Mix solutions of nitrate and iron sulfate
  - b. Add sulfuric acid without mixing
  - c. Brown ring between acid and iron sulfate solution

16. Proteins - Yellow in the presence of nitric acid

17. Oxides of nitrogen

a. Nitric oxide - NO

b. Nitrogen dioxide - NO<sub>2</sub>

c. Nitrous oxide - N<sub>2</sub>O

(1) Called laughing gas

(2) Used as an anesthetic

(3) Equation for preparation  $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} \uparrow + 2\text{H}_2\text{O}$

d. Nitrogen dioxide - A reddish brown poisonous gas

#### D. Explosives

1. First used by Chinese

2. Detonation - A sudden expansion of gases

3. Dynamite - Contains nitroglycerin

4. Guncotton - Contains nitrocellulose

5. Smokeless powder - made by dissolving guncotton and nitroglycerin in acetone

6. Detonators - Sensitive to impact

7. Boosters - Necessary to start some chain explosive reactions

8. Trinitrotoluene - Preparation from toluene and nitric acid in the presence of sulfuric acid

#### II. Attitude toward:

A. Making of our lives more enjoyable through chemistry

B. Understanding things around us through chemistry

C. Understanding through chemistry how plants aid man

D. Becoming more appreciative of things around us

E. Necessity of a knowledge of chemistry for many professions or employments

- F. A knowledge of chemistry as an aid or hinderance to man
- G. The usefulness of ammonia to man
- H. The importance of nitric acid to man

### III. Habit of:

- A. Associating chemistry with the things about us
- B. Using chemistry to explain how things happen whenever possible
- C. Using chemical knowledge in any future study of chemistry
- D. Reading scientific articles in newspapers and magazines
- E. Studying each daily assignment in chemistry
- F. Developing good study habits
- G. Living a healthful and useful life
- H. Trying to see how a knowledge of chemistry will help you

### IV. Appreciation for:

- A. A knowledge of nitrogen and its usefulness to man
- B. The chemistry course of study
- C. Laboratory experimentation
- D. An opportunity to study chemistry
- E. Chemistry and its contributions to man
- F. The aid of the material in this unit in helping to understand the following units

#### Leads to Other Units

#### Nitrogen and Its Compounds

The student should see by now how the knowledge of chemistry that he has gained in studying the past units will aid him in studying the future units.

- VI. The Wonder Element Carbon
- VII. The Periodic Law and chemical families
- VIII. Some important non-metals
- IX. The Metals

Teacher Evaluation  
Nitrogen and Its Compounds

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free informal association of pupils?
3. Provide an opportunity for manipulative activity?
4. Make a coherent whole?
5. Provide a considerable amount of student activity?
6. Produce satisfying outcomes?
7. Provide sufficient concrete and illustrative material?
8. Have a useful purpose in the present and future life of the pupil?
9. Reproduce actual life situations as far as possible?
10. Utilize materials as they occur in life?
11. Contain some accurate material?
12. Provide opportunity for pupils to originate plan and direct activity as far as possible?

Ex.	V.G.	G.	F.	P.	None
✓					
✓					
✓					
	✓				
✓					
		✓			
	✓				
		✓			
		✓			
✓					
		✓			

13. Provide opportunity to judge, choose, and evaluate?
14. End lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete, exact references?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
	✓				
✓					
✓					

### Pupil Test

### Knowledge Test

### Nitrogen and Its Compounds

Complete the following statements to make them read correctly:

- Nitrogen gas is odorless, \_\_\_\_\_ and \_\_\_\_\_.
- Nitrogen is \_\_\_\_\_ soluble in water.
- Nitrogen makes up \_\_\_\_\_ of the earth's atmosphere.
- Write the equation of the reaction of phosphorus and oxygen.  
\_\_\_\_\_.
- Ammonium nitrite decomposes into \_\_\_\_\_ and \_\_\_\_\_.
- Two bacteria that aid in nitrogen fixation are \_\_\_\_\_ and \_\_\_\_\_.
- \_\_\_\_\_ are useful in fertilizers.
- \_\_\_\_\_ are plants that have bacteria in their roots which aid in nitrogen fixation.
- The type of food that contains nitrogen is the \_\_\_\_\_.



10. Ammonia is prepared in the laboratory by the reaction between \_\_\_\_\_ and \_\_\_\_\_.
11. Write the equation of the laboratory preparation of ammonia.  
\_\_\_\_\_.
12. Ammonia reacts with water to form the base \_\_\_\_\_.
13. Write the equation for the reaction of water and ammonia. \_\_\_\_\_  
\_\_\_\_\_.
14. Ammonia has a \_\_\_\_\_ odor.
15. Ammonia is prepared commercially by the \_\_\_\_\_ process.
16. Calcium cyanamide reacts with water to form \_\_\_\_\_ and \_\_\_\_\_.
17. Nitric acid is prepared in the laboratory by the reaction of \_\_\_\_\_ and \_\_\_\_\_.
18. Nitric acid is prepared commercially by oxidizing \_\_\_\_\_.
19. Write the equation for the reaction of dilute nitric acid upon copper.  
\_\_\_\_\_.
20. Aqua regia is a mixture of \_\_\_\_\_ and \_\_\_\_\_ acids.
21. Three oxides of nitrogen are a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_.
22. \_\_\_\_\_ is called laughing gas.
23. \_\_\_\_\_ is used in making dynamite.
24. \_\_\_\_\_ is also called guncotton.
25. \_\_\_\_\_ is a cellulose nitrate used in making films.

Mark the following statements with a plus (+) and a zero (0) for false.

- \_\_\_\_\_ 1. All animal proteins contain nitrogen.
- \_\_\_\_\_ 2. Chile saltpeter is a compound of nitrogen.
- \_\_\_\_\_ 3. Nitrogen burns easily in the presence of oxygen.

- \_\_\_\_\_ 4. Nylon contains nitrogen.
- \_\_\_\_\_ 5. Glue containing urea easily dissolves in water.
- \_\_\_\_\_ 6. Legume plants are capable of making nitrogen compounds.
- \_\_\_\_\_ 7. Nitrogen is necessary for living organisms.
- \_\_\_\_\_ 8. Ammonia is easily compressed.
- \_\_\_\_\_ 9. Ammonium hydroxide is unstable.
- \_\_\_\_\_ 10. Smelling salts sometimes contains ammonium carbonate.
- \_\_\_\_\_ 11. Nitric acid is a strong oxidizing agent.
- \_\_\_\_\_ 12. Nitric acid is corrosive in its action.
- \_\_\_\_\_ 13. Sulfuric acid is used in the test for nitrates.
- \_\_\_\_\_ 14. Nitric acid reacts on all metals to produce free hydrogen.
- \_\_\_\_\_ 15. Nitrogen dioxide is a colorless gas.
- \_\_\_\_\_ 16. Nitrous oxide has the formula  $N_2O$ .
- \_\_\_\_\_ 17. The Chinese were the first to use explosives.
- \_\_\_\_\_ 18. Dynamite contains the explosive nitroglycerin.
- \_\_\_\_\_ 19. Nitroglycerin can be caused to explode by shock.
- \_\_\_\_\_ 20. Nitrocellulose is commonly called guncotton.

#### Key to Knowledge Test

#### Nitrogen and Its Compounds

##### Completion:

1. Colorless, tasteless
2. Slightly soluble
3. 78%
4.  $4P + 5O_2 \rightarrow 2P_2O_5$
5. Water and nitrogen
6. Azotobacter, rhizopus, nitrosomonas, nitrobacter
7. Nitrates

8. Legumes
9. Proteins
10. Ammonium chloride and calcium hydroxide
11.  $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{NH}_4\text{OH}$   
 $2\text{NH}_4\text{OH} \longrightarrow 2\text{NH}_3\uparrow + 2\text{H}_2\text{O}$
12. Ammonium hydroxide
13.  $\text{NH}_3 + \text{H}_2\text{O} \longrightarrow \text{NH}_4\text{OH}$
14. Pungent
15. Haber
16. Ammonia and calcium carbonate
17. Sodium nitrate and sulfuric acid
18. Ammonia
19.  $3\text{Cu} + 8\text{HNO}_3 \longrightarrow 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} \longrightarrow 2\text{NO}\uparrow$
20. Hydrochloric and nitric
21. Nitrous, nitric, nitrogen dioxide
22. Nitrous oxide
23. Nitroglycerine
24. Nitrocellulose
25. Pyroxylin

True and False:

1. +	6. 0	11. +	16. +
2. +	7. +	12. +	17. +
3. 0	8. +	13. +	18. +
4. +	9. +	14. +	19. +
5. 0	10. +	15. 0	20. +

## Pupil Test

## Attitude Test

## Nitrogen and Its Compounds

Check the following statements that are considered to be desirable by you.

- \_\_\_\_\_ 1. Since a knowledge of chemistry sometimes leads to the development of things harmful to man, it should not be taught.
- \_\_\_\_\_ 2. A study of chemistry should only be undertaken by a few pupils.
- \_\_\_\_\_ 3. A study of chemistry has been a help to you
- \_\_\_\_\_ 4. A study of chemistry gives you a better understanding of things about you.
- \_\_\_\_\_ 5. Every person should have some knowledge of chemistry.
- \_\_\_\_\_ 6. The field of chemistry has aided man more than it has harmed him.
- \_\_\_\_\_ 7. Chemistry has improved the standard of living of man.
- \_\_\_\_\_ 8. I like to study chemistry.
- \_\_\_\_\_ 9. Chemistry has been an aid in combating diseases.
- \_\_\_\_\_ 10. Chemistry has improved the foods that we eat.

## Pupil Test

## Habit Test

## Nitrogen and Its Compounds

Check the desirable answers:

- \_\_\_\_\_ 1. I study chemistry regularly.
- \_\_\_\_\_ 2. I get each daily assignment on the day it is assigned.
- \_\_\_\_\_ 3. I learn to spell all new terms found in the subject matter.
- \_\_\_\_\_ 4. I learn the meaning of all new terms found in the subject matter.
- \_\_\_\_\_ 5. I read materials on chemistry other than that assigned to me.

- \_\_\_\_\_ 6. I return all unused chemicals to the reagent bottles.
- \_\_\_\_\_ 7. I try to understand one topic before continuing to the next.
- \_\_\_\_\_ 8. I associate chemistry with every day things whenever possible.
- \_\_\_\_\_ 9. I explain how things happen in terms of chemistry whenever possible.
- \_\_\_\_\_ 10. I encourage other students not to take chemistry because it is hard to understand.

Key to Habit Test

Nitrogen and Its Compounds

All statements should be checked except numbers 6, 10.

Pupil Test

Appreciation Test

Nitrogen and Its Compounds

Write yes or no in front of each statement.

- \_\_\_\_\_ 1. I appreciate how chemistry helps me to understand how chemicals affect my life.
- \_\_\_\_\_ 2. I appreciate how chemistry helps me to understand things occurring in nature.
- \_\_\_\_\_ 3. I appreciate a study of nitrogen and its importance to man.
- \_\_\_\_\_ 4. I appreciate the study of nitric acid and its importance to man.
- \_\_\_\_\_ 5. I appreciate the opportunity to study chemistry in an organized group.
- \_\_\_\_\_ 6. I appreciate the scientific proof that chemistry offers of how things happen.
- \_\_\_\_\_ 7. I appreciate the use of the laboratory in understanding the principles of chemistry.
- \_\_\_\_\_ 8. I appreciate the study of explosives.

- \_\_\_\_\_ 9. I appreciate the study of ammonia and how it is used by man.
- \_\_\_\_\_ 10. I appreciate the fact that chemistry as a subject requires some concentrated study.

### Key to Appreciation Test

#### Nitrogen and Its Compounds

A desirable answer is yes to all questions.

#### Bibliography

##### Teacher

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##### Pupil

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## Unit No. VI

## Carbon

In this unit we discuss organic chemistry--the chemistry of carbon compounds. Organic chemistry has been developing for about a hundred years. Nearly all of the new synthetic medicines are organic compounds. Rubber and rubber substitutes as well as the hundreds of new plastics, are organic substances.<sup>13</sup>

The chemists have not been satisfied with using carbon alone or with using the carbon compounds that occur naturally; they have succeeded in producing a great many new substances which meet man's varied and extensive needs.<sup>14</sup>

The carbon atom's unusual property of being able to combine with other carbon atoms in long chains or in closed rings makes possible the formation of more compounds of carbon than of any other element.<sup>15</sup>

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<sup>13</sup> Biddle - Bush, Chemistry Today, p. 516.

<sup>14</sup> Rawlins - Struble, Chemistry in Action, p. 254.

<sup>15</sup> Biddle - Bush, Chemistry Today, p. 516.



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### Criteria for Evaluation of a Unit<sup>16</sup>

#### Carbon

1. It should involve a variety of direct sensory experiences.

<sup>16</sup>

Caswell - Campbell, Curriculum Development, (American Book Co., New York, 1935); p. 435.

2. It should provide for some free, informal associations of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts should make a coherent whole.
5. It should provide a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present and future life of the pupil.
9. It should reproduce actual life situations, as far as possible.
10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide opportunities to judge, choose, and evaluate.
13. It should provide an opportunity for the pupil to originate, plan, and direct the activity, as far as possible.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice, if she so desires.
16. It should state clearly where materials may be obtained.
17. When references are given, they should be complete and exact.

Grade Placement - Eleventh or Twelfth Grade

Time Allotment - Thirty-five Days

Central Theme - The Wonder Element

## Objectives

## Carbon

## A. Knowledge and Understanding of:

1. Carbon, an interesting element
2. Simple compounds of carbons
3. Fuels
4. Organic Chemistry
5. Derivatives of hydrocarbons
6. Foods
7. Medicines
8. Textiles
9. Rubber and plastics

## B. Attitude toward:

1. Correct study habits
2. Practical use of knowledge of chemistry
3. Chemistry and its aids to man
4. Carbon and its importance to man
5. Creative work

## C. Habit of:

1. Applying previous knowledge of chemistry to the new unit
2. Thinking clearly
3. Reasoning well
4. Associating chemistry with everyday things
5. Studying each assignment completely
6. Applying knowledge gained in class to laboratory work
7. Understanding the purpose of each laboratory experiment

D. Appreciation for:

1. Ability to carry out an experiment satisfactorily
2. Contributions of chemistry to the fight against man's enemies
3. Contributions of chemistry in developing new and better products for man's use
4. Ability to understand things about us
5. Good study habits
6. Good workmanship

Approaches

Carbon

This unit may be effectively introduced by demonstrating the bleaching of brown sugar by carbon. The pouring of carbon dioxide into a glass container which contains several burning candles.

Study Guide No. I

Carbon, an Interesting Element

- A. Discussion of the allotropic forms of carbon
- B. Contrasting diamonds and graphite
- C. Description of the manufacture of artificial graphite
- D. Discussion of the making of artificial diamonds
- E. Definition of destructive distillation

References

- Rawlins - Struble, Chemistry in Action, pp. 255-262.
- Foster, The Romance of Chemistry, pp. 340-348.
- Jaffe, New World of Chemistry, pp. 326-345.

## Subject Matter No. I

## Carbon, an Interesting Element

- I. Diamonds
  - A. Occurrence in nature
  - B. Artificial manufacture
  - C. Properties of
    - 1. Physical
    - 2. Chemical
  - D. Uses of - Industrial
- II. Graphite
  - A. Properties of
    - 1. Physical
    - 2. Chemical
  - B. Preparation of
  - C. Uses of - Industrial
- III. Amorphous Carbon
  - A. Forms of
  - B. Preparation of
  - C. Uses of - Industrial
  - D. Properties of
    - 1. Physical
    - 2. Chemical

## Activities No. I

## Carbon, an Interesting Element

- A. A study of different types of flames
- B. Illustration of reduction by carbon
- C. Illustration of the bleaching action of carbon

## Correlations No. I

## Carbon, an Interesting Element

- A. Reading - Specific references
- B. Writing - Preparation of experiments
- C. Spelling - New terms such as: amorphous, allotropic, graphite, anthracite
- D. English - Meaning of new terms: amorphous, allotropic, anthracite
- E. History - Discovery of diamonds

## Work Sheet No. I

## Carbon, an Interesting Element

Mark the following statements with a plus (+) for true and a zero (0) for false.

- \_\_\_\_\_ 1. Natural diamonds are usually found in regions of volcanic activity.
- \_\_\_\_\_ 2. Pencil lead contains graphite and clay.
- \_\_\_\_\_ 3. Most diamonds are octahedron in shape.
- \_\_\_\_\_ 4. Diamonds are the purest form of carbon.
- \_\_\_\_\_ 5. Pure diamonds are white in color.
- \_\_\_\_\_ 6. Diamonds owe their brilliance to reflected light.
- \_\_\_\_\_ 7. The cutting of a diamond determines some of its brilliance.
- \_\_\_\_\_ 8. The diamond is one of the hardest substances known.
- \_\_\_\_\_ 9. Most of the diamonds are used in making jewelry.
- \_\_\_\_\_ 10. Graphite is non-crystalline in nature.
- \_\_\_\_\_ 11. The chief use of graphite is in the making of lubricants.
- \_\_\_\_\_ 12. Graphite is made by heating coal in an electric furnace.
- \_\_\_\_\_ 13. Carborundum is almost pure graphite produced under pressure.
- \_\_\_\_\_ 14. Carborundum contains silicon as well as graphite.
- \_\_\_\_\_ 15. Carbon found in charcoal is not in the crystal form.



- \_\_\_\_ 16. Charcoal is pure carbon.
- \_\_\_\_ 17. Charcoal is made by burning wood.
- \_\_\_\_ 18. Soot forms when there is an insufficient amount of air in burning a fuel.
- \_\_\_\_ 19. Lampblack is used in printer's ink.
- \_\_\_\_ 20. Coke is made by the destructive distillation of coal.
- \_\_\_\_ 21. Carbon is a good oxidizing agent.
- \_\_\_\_ 22. Carbon has a valence of -3.
- \_\_\_\_ 23. Carbon monoxide has the formula  $\text{CO}_2$ .
- \_\_\_\_ 24. Charcoal can be used to remove odors from the air.
- \_\_\_\_ 25. Carbon is used as a bleaching agent in refining sugar.

#### Key to Work Sheet No. I

##### Carbon, an Interesting Element

1. +	6. 0	11. +	21. 0
2. +	7. +	12. +	22. 0
3. +	8. +	13. 0	23. 0
4. +	9. 0	14. +	24. +
5. 0	10. 0	15. 0	25. +

#### Study Guide No. II

##### Compounds of Carbon

- A. Equations for the preparations of carbon dioxide by heating a carbonate acid upon a carbonate
- B. Laboratory preparation of carbon dioxide
- D. Discussion of physical properties of carbon dioxide
- E. Listing uses of carbon dioxide
- F. Explanation of the acid-soda fire extinguisher
- G. Explanation of how carbon dioxide makes bread light

- H. Explanation of use of carbon dioxide in refrigeration
- I. Definition of photosynthesis
- J. Listing essential things needed in photosynthesis
- K. Writing equation for photosynthesis
- L. Drawing cross section of leaf, label parts
- M. Distinguishing between carbon monoxide and carbon dioxide
- N. Giving formula for carbon disulfide

#### References

- Rawlins - Struble, Chemistry in Action, pp. 263-271.  
Foster - The Romance of Chemistry, pp. 352-359.  
Jaffe, New World of Chemistry, pp. 248-370.

#### Subject Matter No. II

##### Carbon Compounds

- I. Carbon dioxide
  - A. Preparation of
    - 1. Heating carbonate salts
    - 2. Acid on a carbonate or bicarbonate
    - 3. Laboratory preparation
  - B. Properties of
    - 1. Physical
    - 2. Chemical - Reactions
      - a. Metallic oxides
      - b. Water
      - c. Bases
    - 3. Uses of
      - a. Fire extinguishers
        - (1) Carbon dioxide gas

(2) Acid-soda

b. Baking

(1) Baking powders

(2) Chemical action

c. Refrigeration

(1) Liquid carbon dioxide

(2) Solid carbon dioxide

d. War

e. Photosynthesis

(1) Parts of a leaf

(2) Chemical reaction

(3) Equations

II. Carbon monoxide

A. Properties of

1. Physical

2. Chemical

B. Preparation of

1. Laboratory

2. Commercial

III. Carbon disulfide

A. Preparation of

B. Uses of

C. Properties of

Activities No. II

Compounds of Carbon

- A. Prepare carbon dioxide in the laboratory
- B. Demonstrate the acid-soda fire extinguisher
- C. Demonstrate solid carbon dioxide

## Correlations No. II

## Compounds of Carbon

- A. Writing - Procedures in laboratory
- B. Spelling - New terms such as photosynthesis, tartaric acid, stoma, chlorophyll
- C. Reading - Specific references
- D. Biology - Photosynthesis
- E. English - Meaning of new terms, photosynthesis, stoma, chlorophyll

## Work Sheet No. II

## Compounds of Carbon

Complete the following statements:

1. Carbon dioxide was prepared in the laboratory by the action of \_\_\_\_\_ acid upon \_\_\_\_\_.
2. Write the equation for the above reaction. \_\_\_\_\_
3. In the acid-soda fire extinguisher the acid used was \_\_\_\_\_.
4. Write the equation for the chemical action in the acid-soda fire extinguisher.
5. The acid \_\_\_\_\_ is found in sour milk.
6. \_\_\_\_\_ is the process of manufacturing food by a green plant.
7. List four things that are essential for food making by a green plant.  
a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_, d. \_\_\_\_\_.
8. The green coloring of plants is called \_\_\_\_\_.
9. The two products of food making by a green plant are a. \_\_\_\_\_  
b. \_\_\_\_\_.
10. \_\_\_\_\_ is a poisonous compound of carbon and oxygen.

Mark the following statements with a plus (+) for true and a zero (0) for

false.

- \_\_\_\_\_ 1. Carbon dioxide is an odorless gas.
- \_\_\_\_\_ 2. Carbon dioxide is heavier than air.
- \_\_\_\_\_ 3. Carbolic acid is formed when carbon dioxide reacts with water.
- \_\_\_\_\_ 4. An animal may breath pure carbon dioxide without harm to him.
- \_\_\_\_\_ 5. Carbon dioxide will not burn.
- \_\_\_\_\_ 6. Pressure is caused in a fire extinguisher by carbon dioxide.
- \_\_\_\_\_ 7. Baking powders give off carbon dioxide when heated with soda.
- \_\_\_\_\_ 8. Carbon dioxide does not melt or pass through the liquid state.
- \_\_\_\_\_ 9. Oxygen is used by a plant in making food.
- \_\_\_\_\_ 10. Green plants do not make food during the night.

#### Key to Work Sheet No. II

#### Compounds of Carbon

Completion:

1. Hydrochloric, calcium carbonate
2.  $\text{Ca CO}_3 + 2\text{HCl} \rightarrow \text{Ca Cl}_2 + \text{H}_2\text{O} + \text{CO}_2$
3. Sulfuric
4.  $2\text{NaHCO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} + 2\text{CO}_2$
5. Lactic
6. Photosynthesis
7. (a) Water, (b) Carbon dioxide, (c) Sunlight, (d) Chlorophyll
8. Chlorophyll
9. Sugar and oxygen
10. Carbon monoxide

True or false

- |      |      |       |
|------|------|-------|
| 1. + | 5. + | 8. +  |
| 2. + | 6. + | 9. 0  |
| 3. 0 | 7. + | 10. + |
| 4. 0 |      |       |

### Study Guide No. III

#### Fuels

- A. Discussion of things considered in selecting a fuel
- B. Discussion of characteristics of a perfect fuel
- C. Discussion of commonly used solid fuels
- D. Explanation of the formation of peat and coal
- E. Listing liquid fuels used today
- F. Listing gaseous fuels used today
- G. Explanation of chemical action of a burning fuel
- H. Listing of ways we can obtain most heat from a fuel
- I. Discussion of comparative cost of fuels

#### References

- Rawlins - Struble, Chemistry in Action, pp. 273-281.
- Riddle - Bush, Chemistry Today, pp. 577-585.
- Ahrens - Bush - Easley, Living Chemistry, pp. 359-371.
- Foster, The Romance of Chemistry, pp. 341-348.
- Holmes, Out of the Test Tube, pp. 210-222.

### Subject Matter No. III

#### Fuels

- I. Characteristics of a good fuel
- II. Characteristics of a perfect fuel
- III. Solid fuels

- A. Peat
- B. Coal
- C. Lignite

IV. Liquid fuels

- A. Gasoline
- B. Diesel oil
- C. Alcohol-water

V. Gaseous fuels

- A. Natural gas
- B. Coal gas
- C. Water gas
- D. Producer gas
- E. Acetylene

VI. Chemical action of fuels

VII. Economical use of fuels

VIII. Comparison of cost

- A. Units
- B. Calculations

Activities No. III

Fuels

- A. Report on the formation of coal
- B. Report on the formation of petroleum

Correlations No. III

Fuels

- A. Writing - Reports on coal and petroleum
- B. English - Reports on coal and petroleum
- C. Mathematics - Calculations of heat value of fuels
- D. Physics - Heat units, B.T.W., calories

## Work Sheet No. III

## Fuels

Complete the following statements:

1. List five things that should be considered in selecting a fuel for the home.  
a. \_\_\_\_\_ d. \_\_\_\_\_  
b. \_\_\_\_\_ e. \_\_\_\_\_  
c. \_\_\_\_\_
2. Coal is formed principally from \_\_\_\_\_.
3. \_\_\_\_\_ is a poor form of fuel formed from plants.
4. Lignite is formed by putting \_\_\_\_\_ under pressure.
5. Natural gas contains principally \_\_\_\_\_.
6. \_\_\_\_\_ is a gas found in natural gas and used to fill lighter-than-air craft.
7. Coal gas is formed by the destructive distillation of \_\_\_\_\_.
8. Coal gas is composed principally of \_\_\_\_\_.
9. Water gas is composed principally of \_\_\_\_\_ and \_\_\_\_\_.
10. Write the equation for formation of water gas from coke.  
\_\_\_\_\_.
11. \_\_\_\_\_ is produced by the action of water upon calcium carbide.
12. Write the equation of the above reaction \_\_\_\_\_.
13. Write an equation for the burning of methane. \_\_\_\_\_.
14. Heat value of fuel is usually determined in terms of \_\_\_\_\_ per lb.



15. Write an equation for the burning of acetylene \_\_\_\_\_
- 

### Key to Work Sheet No. III

#### Fuels

1. (a) cost, (b) clearliness, (c) convenience, (d) residue left, (e) installation cost
2. Plant matter
3. Peat
4. Peat
5. Methane
6. Helium
7. Coal
8. Methane
9. Carbon monoxide and hydrogen
10.  $\text{H}_2\text{O} + \text{C} \rightarrow \text{CO} + \text{H}_2$
11. Acetylene
12.  $\text{Ca C}_2 + 2\text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_2 + \text{Ca(OH)}_2$
13.  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
14. B. T. U.
15.  $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O}$

#### Study Guide No. IV

- A. Definition of the words organic, organic chemistry
- B. Listing the sources of organic compounds
- C. Explanation of the formation of organic compounds
- D. Comparing structural formulas to molecular formulas
- E. Comparing organic compounds and inorganic compounds as to chemical reactions

- F. Listing substances found in petroleum
- G. Explanation of preparation of these substances
- H. Discussion of fractional distillation of petroleum
- I. Explanation of "octane rating" of gasoline
- J. Explanation of the naming of hydrocarbons
- K. Description of an unsaturated hydrocarbon
- L. Listing organic compounds in coal, wood, bones

#### References

- Rawlins - Struble, Chemistry in Action, pp. 283-295.  
Jaffe, New World of Chemistry, pp. 551-564.  
Biddle - Bush, Chemistry Today, pp. 517-564.

#### Subject Matter No. IV

##### Organic Chemistry

- I. Organic - Contains the elements carbon and hydrogen
- II. Organic chemistry - A study of organic compounds
- III. Sources of organic compounds
  - A. Plants
  - B. Animals
  - C. Plant and animal products
- IV. Number of organic compounds
  - A. Sharing of electrons
  - B. Isomers
- V. Organic formulas
  - A. Structural
  - B. Use of
- VI. Chemical properties of organic compounds
- VII. Petroleum
  - A. Origin

- B. Composition of
- C. Substances in petroleum
  - 1. Name
  - 2. Fractional distillation
- D. Gasoline
  - 1. Cracking process
  - 2. "Octane rating"

VIII. Naming of hydrocarbons

IX. Unsaturated hydrocarbons

- A. Ethylene series
- B. Acetylene series

X. Organic compounds in

- A. Coal
- B. Wood
- C. Bones

Activities No. IV

Organic Chemistry

- A. Laboratory experiment on destructive distillation of wood and coal
- B. Preparation of methane in the laboratory

Correlations No. IV

Organic Chemistry

- A. Reading - Specific references
- B. Writing - Preparing laboratory experiments
- C. Spelling - New terms such as: hydrocarbon, isomere, petroleum, ethylene, acetylene

## Work Sheet No. IV

## Organic Chemistry

Mark the following statements with a plus (+) for true and a zero (0) for false.

- \_\_\_\_\_ 1. Organic compounds contain only two elements, hydrogen and carbon.
- \_\_\_\_\_ 2. Foods are organic compounds.
- \_\_\_\_\_ 3. We obtain organic compounds from living plants and animals.
- \_\_\_\_\_ 4. There are more inorganic compounds than there are organic compounds.
- \_\_\_\_\_ 5. Organic compounds are formed by sharing electrons.
- \_\_\_\_\_ 6. It is possible for two organic compounds to have the same empirical formulas.
- \_\_\_\_\_ 7. No two organic compounds may have the same structural formulas.
- \_\_\_\_\_ 8. Most organic compounds are soluble in water.
- \_\_\_\_\_ 9. As a group, organic compounds are easily decomposed by heat.
- \_\_\_\_\_ 10. Organic compounds ionize freely when in solution.
- \_\_\_\_\_ 11. Petroleum is formed from the decomposition of animal remains.
- \_\_\_\_\_ 12. Hydrocarbons contain only hydrogen and carbon.
- \_\_\_\_\_ 13. Petroleum is an organic compound.
- \_\_\_\_\_ 14. Kerosene is a mixture of hydrocarbon compounds.
- \_\_\_\_\_ 15. "Cracking" of petroleum products increases the yield of gasoline from petroleum.
- \_\_\_\_\_ 16. Coke is a product of the process of "cracking" of petroleum.
- \_\_\_\_\_ 17. 90 "octane" gasoline contains more isooctane than 80 "octane."
- \_\_\_\_\_ 18. Unsaturated hydrocarbons do not have enough hydrogen in them.
- \_\_\_\_\_ 19. Ethylene is an unsaturated hydrocarbon.
- \_\_\_\_\_ 20. Acetylene has the formula  $C_2H_2$ .
- \_\_\_\_\_ 21. Acetylene is obtained from calcium carbide.

- \_\_\_\_\_ 22. Methanol is obtained from coal.
- \_\_\_\_\_ 23. Coke is a product of destructive distillation of wood.
- \_\_\_\_\_ 24. Pyridine is obtained from the destructive distillation of bones.
- \_\_\_\_\_ 25. Benzene has the carbons arranged in a ring.

## Key to Work Sheet No. IV

## Organic Chemistry

1. 0	6. +	11. +	16. +	21. +
2. +	7. +	12. +	17. +	22. 0
3. +	8. 0	13. 0	18. +	23. 0
4. 0	9. 0	14. +	19. +	24. +
5. +	10. 0	15. +	20. +	25. +

## Study Guide No. V

## Derivatives of Hydrocarbons

- A. Discussion of the formation of methyl chloride
- B. Discussion of the substitution of a halogen in the methane compound
- C. Definition of an alcohol
- D. Listing of the common alcohols
- E. Discussion of formation of ethanol
- F. Discussion of effects of alcohol upon the human body
- G. Definition of ester, aldehydes, ketones
- H. Discussion of formation of esters
- I. Discussion of formation of soap

## References

- Rawlins - Struble, Chemistry in Action, pp. 295-308
- Holmes, Out of the Test Tube, pp. 247-252.

## Subject Matter No. V

## Derivatives of Hydrocarbons

## I. Halogen substitutions

- A. Names of halogens
- B. Formation of methyl chloride
- C. D. D. T.

## II. Alcohols

- A. Definition of
- B. Methanol
  - 1. Formula
  - 2. Other names
  - 3. Preparation of
  - 4. Properties of
  - 5. Uses of
  - 6. Paint remover
- C. Ethanol
  - 1. Formula
  - 2. Preparation of
    - a. Fermentation
    - b. Purification of
  - 3. Properties of
  - 4. Effects upon human body
  - 5. Uses of

## III. Ether

- A. Formula
- B. Preparation

## IV. Aldehydes

- A. Formula
- B. Preparation
- C. Formaldehyde
  - 1. Preparation
  - 2. Properties
  - 3. Uses

V. Ketone

- A. Formula
- B. Acetone

VI. Organic acids

- A. Formula, general
- B. Acetic acid
- C. Malic acid
- D. Tartaric acid

VII. Esters

- A. Definition of
- B. Preparation of
- C. Uses of

VIII. Soap

- A. Preparation of
- B. Use of

Activities No. V

Derivatives of Hydrocarbons

- A. Preparation of an ester in the laboratory
- B. Preparation of soap in the laboratory
- C. Visiting a local distillery

## Correlations No. V

## Derivatives of Hydrocarbons

- A. Health - Effects of alcohol upon the body
- B. Biology - Effects of alcohol upon the body
- C. Reading - Specific references
- D. Writing - Laboratory procedures
- E. Spelling - New terms such as, glycerol, ethylene, glycol, methanol, ethanol, esters, ether, aldehydes, ketone, tartaric

## Work Sheet No. V

## Derivatives of Hydrocarbons

Mark the following statements true with a plus (+) sign and false with a zero (0) sign.

- \_\_\_\_\_ 1. D.D.T. is a compound formed by the substitution of halogen in an hydrocarbon.
- \_\_\_\_\_ 2. All alcohols contain an hydroxal group.
- \_\_\_\_\_ 3. Alcohols do not ionize with a free hydroxal group.
- \_\_\_\_\_ 4. Methanol has the formula  $\text{CH}_3\text{OH}$ .
- \_\_\_\_\_ 5. Methanol is found in all alcoholic beverages.
- \_\_\_\_\_ 6. Methanol is used principally as an industrial solvent.
- \_\_\_\_\_ 7. Methyl alcohol is used as a cheap antifreeze.
- \_\_\_\_\_ 8. Denatured alcohol may contain methyl alcohol.
- \_\_\_\_\_ 9. Ethanol has the formula  $\text{C}_2\text{H}_5\text{OH}$ .
- \_\_\_\_\_ 10. In preparing ethanol, starch is hydrolized into glucose.
- \_\_\_\_\_ 11. Fermentation is brought about by the action of enzymes.
- \_\_\_\_\_ 12. Fermentation produces nearly 95 per cent alcohol.
- \_\_\_\_\_ 13. Sacrose is fermented by yeast into ethyl alcohol.
- \_\_\_\_\_ 14. Grain alcohol is thought to be a mild stimulant.



- \_\_\_\_\_ 15. Grain alcohol was one of the early anesthetics.  
 \_\_\_\_\_ 16. Grain alcohol in large quantities will produce stupor or sleep.  
 \_\_\_\_\_ 17. Denatured alcohol contains a poison or a nauseating substance.  
 \_\_\_\_\_ 18. Prestone antifreeze contains an alcohol.  
 \_\_\_\_\_ 19. Ethylene glycol does not boil away when used as an antifreeze.  
 \_\_\_\_\_ 20. Ether is a compound made from ethanol.  
 \_\_\_\_\_ 21. Diethyl ether is used as an anesthetic.  
 \_\_\_\_\_ 22. Formaldehyde is an ether of methyl alcohol.  
 \_\_\_\_\_ 23. Formaldehyde is often used as a germicide.  
 \_\_\_\_\_ 24. Acetone is a ketone.  
 \_\_\_\_\_ 25. Aspirin is an organic acid.  
 \_\_\_\_\_ 26. Esters are formed by the action of an acid upon an alcohol.  
 \_\_\_\_\_ 27. Glycerol is a by-product of soap making.  
 \_\_\_\_\_ 28. The use of potassium hydroxide in making soap results in a soft soap.  
 \_\_\_\_\_ 29. Sodium soaps do not harden into a cake.  
 \_\_\_\_\_ 30. Hard water uses more soap than soft water.

## Key to Work Sheet No. V

## Derivatives of Hydrocarbons

1. +	9. +	17. 0	24. +
2. +	10. 0	18. +	25. +
3. +	11. +	19. +	26. +
4. +	12. 0	20. +	27. +
5. 0	13. +	21. +	28. +
6. +	14. 0	22. 0	29. 0
7. 0	15. +	23. +	30. +
8. +	16. +		

## Study Guide No. VI

## Foods

- A. Listing of five classes of substances necessary for proper growth of the human body
- B. Definition of carbohydrate
- C. Listing of different kinds of carbohydrates
- D. Discussion of the processing of sucrose
- E. Definition of starch, dextrins
- F. Discussion of the composition of fats
- G. Discussion of the composition of proteins
- H. Discussion of vitamins as to sources, uses, composition
- I. Discussion of the use of foods by the body

## References

- Rawlins - Struble, Chemistry in Action, pp. 309-324.  
 Ahrens - Bush - Easley, Living Chemistry, pp. 309-324.  
 Holmes, Out of the Test Tube, pp. 253-266.

## Subject Matter No. VI

## Foods

- I. Necessary for growth
  - A. Carbohydrates
  - B. Fats
  - C. Proteins
  - D. Minerals
  - E. Vitamins
- II. Carbohydrates
  - A. Monosaccharides -  $C_6H_{12}O_6$ 
    1. Glucose
      - a. Source of all other foods

b. Made by green plants

c. Energy reaction  $C_6H_{12}O_6 \rightarrow 6H_2O + 6CO_2$

d. Test for

2. Fructose

B. Sucrose

1. Formula

2. Hydrolysis of

3. Sources of

4. Commercial preparation

C. Maltose - Lactose

D. Polysaccharides

1. Starch

a. Sources

b. Hydrolysis of

2. Dextrine

III. Fats

A. Composition of

B. Hydrolysis

C. Uses in human body

IV. Proteins

A. Composition of

B. Hydrolysis of

C. Uses of in human body

D. Sources of

E. Amino acids

V. Minerals

A. Elements needed by human body

B. Sources of

# VI. Vitamins

A. Uses of in the human body

B. Sources of

# VII. Basic seven wheel

## Activities No. VI

### Foods

- A. Testing for sugars, proteins, starch, fats
- B. Preparation of a chart on foods showing name, source, use of

## Correlations No. VI

### Foods

- A. Health - Foods and nutrition
- B. Biology - Digestion of foods
- C. Reading - Specific references
- D. Writing - Preparing food chart

## Work sheet No. VI

### Foods

Complete the following statements with the proper word or words:

1. The five classes of foods needed by the human body are a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_ d. \_\_\_\_\_  
e. \_\_\_\_\_
2. \_\_\_\_\_ is a group of energy foods that contain hydrogen, carbon, and oxygen.
3. The \_\_\_\_\_ includes all the simple sugars with the formula of \_\_\_\_\_.
4. \_\_\_\_\_ is the simple sugar made by green plants.
5. Write the chemical equation for the oxidation of glucose.

6. Glucose changes Fehlings solution from blue to \_\_\_\_\_ in color.
7. Table sugar is called \_\_\_\_\_ and has the formula \_\_\_\_\_.
8. Digestion changes table sugar into \_\_\_\_\_.
9. The three plants that provide most of our sucrose are a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_.
10. \_\_\_\_\_ is used to remove color from sugar making it white.
11. Complex carbohydrates are called \_\_\_\_\_.
12. Starch is changed into \_\_\_\_\_ by digestion.
13. The formula for starch is usually written as \_\_\_\_\_.
14. Starch in bread is changed into \_\_\_\_\_ when the bread is toasted.
15. A \_\_\_\_\_ is a glyceryl ester of a fatty acid.
16. Digestion of fats changes them into \_\_\_\_\_ and \_\_\_\_\_.
17. Foods needed for tissue building are called \_\_\_\_\_.
18. Proteins are digested into \_\_\_\_\_.
19. Proteins contain the element \_\_\_\_\_  
in addition to carbon, hydrogen, and oxygen.
20. \_\_\_\_\_ are essential in the diet to bring about proper use of other foods.
21. Four minerals needed by the body are a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_ d. \_\_\_\_\_.
22. Three of the best sources of proteins are a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_.
23. Five vitamins needed by the body are a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_ d. \_\_\_\_\_ e. \_\_\_\_\_.

24. Vitamin \_\_\_\_\_ prevents scurvy.
25. Vitamin \_\_\_\_\_ is essential for blood clotting.

## Key to Work Sheet No. VI

## Foods

1. Carbohydrates, fats, proteins, minerals, vitamins
2. Carbohydrates
3. Monosaccharides
4. Glucose
5.  $C_6H_{12}O_6 + 6 O_2 \rightarrow 6H_2O + 6CO_2$
6. Red
7. Sucrose,  $C_{12} H_{22} O_{11}$
8. Glucose
9. Sugar cane, maple trees, beets
10. Charcoal
11. Polysaccharides
12. Glucose
13.  $(C_6 H_{12} O_5)_n$
14. Dextrins
15. Fat
16. Glycerol, fatty acids
17. Proteins
18. Amino acids
19. Nitrogen
20. Vitamins
21. Calcium, phosphorus, iron, copper
22. Meat, fowl, fish, soybeans, milk, egg
23. A, B<sub>1</sub>, B<sub>2</sub>, D, C, K, E

24. C

25. K

### Study Guide No. VII

#### Medicines

- A. Definition of antiseptic, disinfectant, germicidal
- B. Listing of some common antiseptics
- C. Listing of some common disinfectants
- D. Definition of anesthetic
- E. Listing of some common anesthetics
- F. Definition of narcotic
- G. Listing of some common narcotics
- H. Distinguishing between vaccines and serums
- I. Distinguishing between laxatives, cathartics, and purgatives

#### References

- Rawlins - Struble, Chemistry in Action, pp. 325-330.
- Ahrens - Bush - Easley, Living Chemistry, pp. 198-225.
- Holmes, Out of the Test Tube, Chapter 23.

### Subject Matter No. VII

#### Medicines

- I. Antiseptics
  - A. Definition
  - B. Common antiseptics
- II. Disinfectants
  - A. Definition
  - B. Common antiseptics
- III. Anesthetics
  - A. Definition

B. Common anesthetics

C. Preparation of

#### IV. Narcotics

A. Definition of

B. Common narcotics

#### V. Serums

A. Definition

B. Uses of

#### VI. Vaccines

A. Definition

B. Uses of

#### VII. Laxatives, cathartics, purgatives

A. Distinguish between

B. Action of

C. Danger of use

#### Activities No. VII

##### Medicines

A. A report on the life of Edward Jenner

B. A report on the life of Louis Pasteur

#### Correlations No. VII

##### Medicines

A. Biology - Study of narcotics, anesthetics, laxatives

B. Health - Study of narcotics, anesthetics, laxatives

C. English - Reports

D. Writing - Reports

E. Reading - Specific references

F. Spelling - New terms such as anesthetic, narcotic, purgative, cathartic



## Work Sheet No. VII

## Medicines

Complete the following statements to make them read correctly:

1. The three general types of bacteria are: a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_
2. An \_\_\_\_\_ is a substance that arrests the activity of most harmful bacteria.
3. A \_\_\_\_\_ is a substance that halts the growth of or destroys microorganisms.
4. A \_\_\_\_\_ is any chemical that kills disease producing organisms.
5. Phenol is a \_\_\_\_\_.
6. Iodine is a \_\_\_\_\_.
7. Merthiolate is a \_\_\_\_\_.
8. Penicillin is a \_\_\_\_\_.
9. An \_\_\_\_\_ is any substance that will relieve pain.
10. Three commonly used anesthetics are: a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_.
11. A \_\_\_\_\_ is a drug which produces stupor or complete insensibility.
12. \_\_\_\_\_ are composed of the watery part of blood and contain antitoxins.
13. \_\_\_\_\_ contain dead disease producing germs.
14. List four ways that a laxative acts in the body. a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_ d. \_\_\_\_\_.
15. Name four common narcotics. a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_ d. \_\_\_\_\_.

## Key to Work Sheet No. VII

## Medicines

1. Cocci, bacilli, spirilla
2. Antiseptic
3. Disinfectant
4. Germicidal
5. Disinfectant
6. Antiseptic
7. Antiseptic
8. Germicidal
9. Anesthetic
10. Ether, nitrous oxide, ethylene
11. Narcotic
12. Serums
13. Vaccines
14. (a) Lubricating and softening  
(b) Giving bulk to fecal matter  
(c) Increasing density of fecal matter  
(d) Stimulating certain nerves
15. Cocaine, codeine, heroin, morphine, marijuana

## Study Guide No. VIII

## Textiles

- A. Listing of sources of natural textile fibers
- B. Listing of characteristics of each natural textile fiber
- C. Listing of some common synthetic fibers
- D. Distinguishing between the different synthetic fibers
- E. Listing precautions to take in home laundering different fibers

- F. Giving rules to be followed in removing spots and stains
- G. Description of test for different types of textile fibers

#### References

- Rawlins - Struble, Chemistry in Action, pp. 332-348.
- Ahrens - Bush - Easley, Living Chemistry, pp. 246-278.
- Holmes, Out of the Test Tube, pp. 186-197.

#### Subject Matter No. VIII

#### Textiles

##### I. Natural textiles

###### A. Plant

###### 1. Cotton

###### a. Source

###### b. Characteristics of

###### 2. Flax

###### a. Linen

###### b. Characteristics of

###### B. Animal

###### 1. Wool

###### a. Characteristics of

###### b. Uses of

###### 2. Silk -- characteristics of

##### II. Synthetic fibers

###### A. Rayon

###### 1. Preparation of

###### 2. Characteristics of

###### B. Nylon

###### 1. Preparation of

2. Characteristics of

- C. Koro seal
- D. Vinylidene chloride
- E. Vinyon
- F. Aralac
- G. Characteristics of

1. Size

2. Properties of

III. Home laundering

IV. Dry cleaning

V. Removal of spots and stains

VI. Identification

- A. Microscopic
- B. Burning test
- C. Solubility test
- D. Color reactions

Activities No. VIII

Textiles

- A. Preparation of laboratory procedures on removal of stains
- B. Identifying different textiles in the laboratory

Correlations No. VIII

Textiles

- A. Reading - Specific references
- B. Writing - Laboratory procedures
- C. Health - Clothing and health

## Work Sheet No. VIII

## Textiles

Complete the following statements to read correctly:

1. Natural textiles may be obtained from either \_\_\_\_\_ or \_\_\_\_\_.
2. Linen is made from \_\_\_\_\_.
3. The two chief plant textile fibers are: a. \_\_\_\_\_ b. \_\_\_\_\_.
4. \_\_\_\_\_ and \_\_\_\_\_ are two important animal textile fibers.
5. \_\_\_\_\_ is the warmest textile fiber.
6. List three synthetic textile fibers, a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_.
7. \_\_\_\_\_ is made from cellulose.
8. \_\_\_\_\_ is impervious to moisture, mildew, mold, decay and termites.
9. \_\_\_\_\_ is just as strong when wet as when dry.
10. \_\_\_\_\_ is a noncombustible fluid used in dry cleaning.
11. \_\_\_\_\_ fibers appear as flattened, twisted ribbons under the microscope.
12. \_\_\_\_\_ fibers are round and resemble bamboo under the microscope.
13. \_\_\_\_\_ has the surface covered with scales.
14. Odors of burning animal fibers resembles the odor of burning \_\_\_\_\_.
15. \_\_\_\_\_ melts when heated.
16. \_\_\_\_\_ is dissolved in hydrochloric acid.
17. \_\_\_\_\_ will dissolve in sodium hydroxide.
18. \_\_\_\_\_ is soluble in acetic acid.
19. \_\_\_\_\_ turns yellow in nitric acid.

20. List four inflammable dry cleaning agents: a. \_\_\_\_\_  
 b. \_\_\_\_\_ c. \_\_\_\_\_ c. \_\_\_\_\_.

## Key to Work Sheet No. VIII

## Textiles

1. Plants, animals
2. Flax
3. Cotton, flax
4. Wool and silk
5. Wool
6. Rayon, nylon, koroseal, vinyon
7. Rayon
8. Nylons
9. Vinyon
10. Carbon tetrachloride
11. Cotton
12. Linen
13. Wool
14. Hair
15. Nylon
16. Silk or rayon
17. Wool or silk
18. Nylon, vinyon
19. Wool or silk
20. Gasoline, benzine, alcohol, naphtha

## Study Guide No. IX

## Rubber and Plastics

- A. Description of the securing of natural rubber

- B. Discussion of the treatment of latex
- C. Discussion of chemical composition of rubber
- D. Definition of vulcanization of rubber
- E. Listing of the synthetic rubbers
- F. Explanation of the production of each synthetic rubber
- G. Definition of plastics
- H. Discussion of the production of plastics
- I. Listing common plastics
- J. Explanation of how each plastic is made

#### References

- Rawlins - Struble, Chemistry in Action, pp. 348-358.  
Biddle - Bush, Chemistry Today, pp. 613-627, 634-648.

#### Subject Matter No. IX

#### Rubber and Plastics

##### I. Rubber

##### A. Natural

- 1. Sources
- 2. Hevea tree
- 3. Latex
- 4. Treatment
- 5. Chemical composition
- 6. Vulcanization

##### B. Synthetic

- 1. Comparison to natural
- 2. Neoprene
  - a. Preparation
  - b. Properties

3. Buna
  - a. Preparation
  - b. Buna - S
  - c. Buna - N
4. Butyl
  - a. Preparation
  - b. Characteristics
5. Thiokol - Uses of

## II. Plastics

- A. Definition of
- B. Nature of
- C. Preparation of
- D. Classification of
  1. Thermoplastics
    - a. Synthetic cellulose
    - b. Uses of Vinyl resins
  2. Thermosetting
    - a. Bakelite
    - b. Acrylic resin
    - c. Styrene

### Activities No. IX

#### Rubber and Plastics

- A. A report on the development of plastics
- B. Showing the following films:
  1. Synthetic Rubber, U.S. Dept. of Interior, Bureau of Mines  
Experiment Station, 4800, Forbes Street, Pittsburgh 13, Pa.
  2. Grass and Farm Chemistry, DeVry Films and Laboratories,  
1111 Armitage Avenue, Chicago 14, Ill.



## Correlations No. IX

## Rubber and Plastics

- A. Spelling - New terms such as, latex, coagulating, isoprene, vulcanization  
neoprene, butadiene, styrene acrylic, vinyl
- B. Reading - Specific references

## Work Sheet No. IX

## Rubber and Plastics

Mark the following statements true with a plus (+) sign and false with a zero (0) sign.

- \_\_\_\_\_ 1. Natural rubber is made from a liquid called latex.
- \_\_\_\_\_ 2. Natural rubber can only be obtained from the Hevea tree.
- \_\_\_\_\_ 3. Latex from the Hevea tree is about 40 per cent latex or rubber.
- \_\_\_\_\_ 4. Curd is coagulated latex.
- \_\_\_\_\_ 5. Rubber is a hydrocarbon.
- \_\_\_\_\_ 6. Natural rubber is made up of only isoprene molecules.
- \_\_\_\_\_ 7. Vulcanized rubber is made by heating crude rubber to a high temperature.
- \_\_\_\_\_ 8. Untreated rubber oxidizes easily.
- \_\_\_\_\_ 9. The more sulfur that is added to rubber the harder it becomes.
- \_\_\_\_\_ 10. Synthetic rubber resists abrasion and tearing better than natural rubber.
- \_\_\_\_\_ 11. Synthetic rubber is more resistant to oxidation than natural rubber.
- \_\_\_\_\_ 12. Neoprene is made from acetylene.
- \_\_\_\_\_ 13. Neoprene is easily affected by heat and oils.
- \_\_\_\_\_ 14. Buna - S rubber is made from butadiene and styrene.
- \_\_\_\_\_ 15. Butadiene is made from alcohol.

- \_\_\_\_ 16. Butyl rubber can be vulcanized like natural rubber.
- \_\_\_\_ 17. All plastics are synthetic compounds.
- \_\_\_\_ 18. Thermoplastic resins cannot be remelted once they have hardened.
- \_\_\_\_ 19. Cellulose is a thermoplastic.
- \_\_\_\_ 20. "Safety film" is made from cellulose acetate.
- \_\_\_\_ 21. Casein in milk can be used to make plastics.
- \_\_\_\_ 22. Bakelite is a thermosetting resin.
- \_\_\_\_ 23. Plexiglas is an acrylic resin.
- \_\_\_\_ 24. Vinyl resins can be reheated and melted once they have hardened.
- \_\_\_\_ 25. Vinyl resins will not burn.

#### Key to Work Sheet No. IX

##### Rubber and Plastics

1. +	6. +	11. +	16. +	21. +
2. 0	7. 0	12. +	17. 0	22. +
3. +	8. +	13. 0	18. 0	23. +
4. +	9. +	14. +	19. +	24. +
5. +	10. 0	15. +	20. +	25. +

##### Culminating Activities

##### Carbon

Show the following films:

1. Crude Oil Distillation, Shell Oil Co.
2. Gift of Green, Modern Talking Picture Service
3. How Rayon is Made, American Viscose

##### Desirable Outcomes

##### Carbon

1. Knowledge and Understanding of:
  - A. Carbon, an interesting element

1. Diamonds - Found
  - a. Found in regions of volcanic activity
  - b. Purest form of carbon
  - c. Synthetically produced but of no value
  - d. Have different colors due to impurities
  - e. Brilliance due to refraction of light
  - f. Hardness makes it useful as a cutting tool
  - g. Used principally for industrial purposes
2. Graphite
  - a. Crystalline in nature
  - b. Used as a lubricant
  - c. Used in making pencil lead
  - d. Prepared synthetically by heating anthracite coal with sand and ferric oxide
  - e. Carborundum - silicon carbide
3. Amorphous carbon
  - a. Charcoal
    - (1) Made by heating wood in the absence of air
    - (2) Very porous - accounts for its great absorptive power
    - (3) Activated charcoal - made by heating charcoal in a retort
  - b. Lampblack - forms when fuels are burned in limited air
  - c. Coke
    - (1) Made by heating coal in the absence of air
    - (2) Excellent reducing agent
4. Carbon atom
  - a. Has four electrons in outer orbit
  - b. Amphoteric in nature
  - c. Inert under ordinary conditions

## B. Compounds of carbon

## 1. Carbon dioxide

a. Prepared by heating a carbonate  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \uparrow$

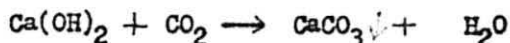
b. Prepared by action of acid upon carbonate

c. Colorless, odorless, tasteless gas

d. Insoluble in water

e. Makes up .04 per cent of air

f. Reacts with metallic hydroxides to form carbonates



g. Used in putting out fires

h. Gas generated in acid-soda fire extinguisher

i. Foam fire extinguishers - used in putting out oil fires

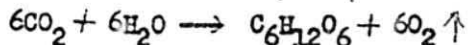
j. Used in making soft drinks

k. Released from baking powders to cause dough to rise

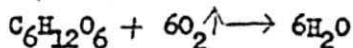
l. Sold a "dry ice" for refrigeration purposes

m. Used by green plants in photosynthesis

n. Changed into sugar by photosynthesis



c. Formed when any fuel is oxidized

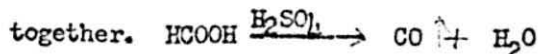


## 2. Carbon monoxide

a. Colorless, poisonous, odorless gas

b. Formed during incomplete combustion

c. Prepared in lab by heating formic acid and sulfuric acid



d. Given off from exhaust pipes of cars

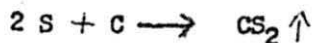
e. Causes many deaths

f. Forms stable compound with hemoglobin in blood

g. Burns forming carbon dioxide

3. Carbon disulfide

a. Formed by passing sulfur vapor over coke



b. Used as an insecticide

C. Fuels

1. Solid fuels

a. Wood - poorest form

b. Coal

(1) Formed from plant tissue

(2) Carbonized under pressure and high temperature

(3) Peat - early form of coal

(4) Lignite - formed from peat

(5) Two kinds

(a) Bituminous

(b) Anthracite

2. Liquid fuels

a. Gasoline - obtained from petroleum

b. Diesel - obtained from petroleum

c. Alcohol - mixed with gasoline

3. Gaseous fuels

a. Natural gas

(1) Obtained from wells

(2) Principally methane

b. Coal gas

(1) Formed by destructive distillation of coal

(2) Principally methane and hydrogen

## c. Water gas

- (1) Formed by passing steam over hot coke
- (2) Poor fuel

## d. Producer gas

- (1) Formed by passing steam and limited air over burning coal
- (2) More than one half hydrogen

## e. Acetylene

- (1) Produced by passing water into calcium carbide
- (2) Used in oxyacetylene torches

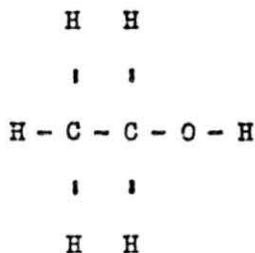
## B. Organic chemistry

## 1. A study of organic compounds

## 2. Organic - A part of a living organism or has been a part of

## 3. Organic compounds

- a. Large number due to amphoteric property of carbon
- b. Numerous because of sharing of electrons of carbon atoms
- c. Using of structural formulas because so many compounds have some imperical formula
- d. Illustration of structural formula



- e. Not soluble in water like inorganic compounds
- f. Easily decomposed by heat
- g. Do not ionize

## 4. Petroleum

- a. Formed from decaying animal tissue
- b. A mixture of many hydrocarbons
- c. Separate hydrocarbons obtained by fractional distillation
- d. Gasoline - a mixture of hydrocarbons
- e. Kerosene - a mixture of hydrocarbons
- f. Cracking of petroleum increases yield of gasoline

## 5. Hydrocarbons

- a. Contain only hydrogen and carbon atoms
- b. Unsaturated hydrocarbons lack hydrogen

## E. Derivatives of hydrocarbons

- 1. Halogen substitution - Halogen takes the place of a hydrogen atom

## 2. Alcohols

## a. Methanol - Methyl alcohol

- (1) Obtained by destructive distillation of wood
- (2) Formula -  $\text{CH}_3\text{OH}$
- (3) Poisonous
- (4) Used in medicines, perfumes, photography, varnishes
- (5) Can not be used as an antifreeze
- (6) Used to denature ethyl alcohol

## b. Ethanol - Ethyl alcohol - grain alcohol

- (1) Formula -  $\text{C}_2\text{H}_5\text{OH}$
- (2) Prepared by fermentation of maltose
- (3) Maltose
  - (a) Formed by hydrolysis of starch
  - (b) Enzyme diastase necessary
- (4) Fermentation mixture - 8 - 12% alcohol
- (5) Concentrated by distillation

- (6) A narcotic
- (7) Acts on nerves
- (8) Produces stupor in large amounts
- c. Glycerol
  - (1) Formula  $C_3H_5 - (OI)_3$
  - (2) By-product of soap making
  - (3) Used in lotions, cosmetics and manufacture of nitroglycerine
- d. Ethylene glycol
  - (1) Used as an antifreeze
  - (2) Sold as prestone
- e. Compounds of
  - (1) Ether
    - (a) Formed when ethyl alcohol is heated with sulfuric acid
    - (b) Used as an anesthesia
  - (2) Formaldehyde - Formed when methanol is oxidized
  - (3) Ketone - Acetone
    - (a) Used in finger nail polish removers
    - (b) Used as solvent
- 4. Organic acids
  - a. Contain the carboxyl group
  - b. Acetic acid
    - (1) Formed by fermentation of "hard cider"
    - (2) Prepared commercially by oxidation of acetaldehyde
- 5. Esters
  - a. Found in odors and flavors of flowers and fruits
  - b. Formed by action of acid upon alcohol
- 6. Soap



- a. Formed by action of an alkali upon a fat
- b. Glycerine - a by-product
- c. Forming of soft soap by use of KOH
- d. Forming of hard soap by use of NaOH

#### F. Foods

##### 1. Five classes

- a. Carbohydrates
- b. Fats
- c. Proteins
- d. Minerals
- e. Vitamins

##### 2. Carbohydrates

- a. Composed of sugars and starches
- b. Simple sugars - Monosaccharides
  - c. Glucose
    - (1) Formula -  $C_6H_{12}O_6$
    - (2) Used as source of energy
    - (3) Reacts with Fehlings solution to form red precipitate
- d. Sucrose - Table sugar
  - (1) Formula -  $C_{12}H_{22}O_{11}$
  - (2) Obtained from sugar cane, beets, maple sap
  - (3) Hydrolyzes into glucose and fructose
- e. Starches
  - (1) Called a polysaccharide
  - (2) Hydrolyzes into glucose
  - (3) Found in potatoes, rice, corn
- f. Dextrins - Formed by heating starch

## 3. Fats

- a. Hydrolyzes into fatty acids and glycerine
- b. Source of energy for the body

## 4. Proteins

- a. Used to build tissue
- b. Contains the element nitrogen
- c. Contains other elements such as sulfur, iron, copper
- d. Hydrolyzes into amino acids
- e. Formed by linking of amino acids

## 5. Minerals

- a. Necessary for all types of proteins
- b. Body needs twelve or more

## 6. Vitamins

- a. Serve as a catalyst
- b. Prevent various diseases
- c. Not used up by body

## G. Medicines

1. Antiseptics - Arrest the growth of bacteria

2. Disinfectant - Halts growth of bacteria

3. Germicide - Kills bacteria

## 4. Anesthetics

- a. Decrease pain
- b. Nitrous oxide first used
- c. Ether - Made from alcohol
- d. Ethylene - Replacing ether

## 5. Narcotic

- a. Produces stupor or complete insensibility

- b. Habit forming
- 6. Serums - Contain antitoxins
- 7. Vaccines
  - a. Produce active immunity to some diseases
  - b. Developed by Jenner and Pasteur
  - c. Contain dead organisms
- 8. Laxatives - cathartics, purgatives
  - a. Used to relieve constipation
  - b. Habit forming
  - c. Dangerous to use some kinds
- H. Textiles
  - 1. Natural textiles
    - a. Secured from plants and animals
    - b. Most used plant fibers
      - (1) Cotton
      - (2) Flax
    - c. Production of linen into flax
    - d. Kinds from animals
      - (1) Wool
      - (2) Silk
    - e. Wool the warmest of all
    - f. Wool possesses great elasticity and resiliency
    - g. Silk - Valued for its strength and luster
    - h. Cotton - Valued because it launders well
  - 2. Synthetic fibers
    - a. Rayon
      - (1) Made by the viscose process

- (2) Acetate process sometimes used
- (3) Products are
  - (a) Cellulose
  - (b) Cellulose acetate
- (4) Viscose products
  - (a) Uses cellulose from spruce, hemlock and other woods
  - (b) Cellulose soaked in sodium hydroxide
- b. Nylons
  - (1) Possesses great elasticity
  - (2) Impervious to moisture, mildew, mold, decay and termites
- c. Koro-seal - used to coat cotton, silk and rayon for water proofing
- d. Vinylidene chloride - used for seat covers and fishing leaders
- e. Vinylite
  - (1) Strongest fiber known
  - (2) Equally as strong when wet as dry
  - (3) Can not be heated
  - (4) Used in making waterproof articles
- 3. Home laundering
  - a. Wash cottons and linens
  - b. Wools and rayons
    - (1) Wash in lukewarm water
    - (2) Wash in mild soap
    - (3) Do not ring out
    - (4) Pull to original shape and size
- 4. Dry cleaning
  - a. Use a noninflammable material

b. Carbon tetrachloride good for this

5. Identification

a. Microscopic

- (1) Cotton - Flattened, twisted ribbons
- (2) Linen - Cylindrical shape, resembles bamboo
- (3) Wool - Covered with overlapping scales
- (4) Silk - Thin, cylindrical red like filament

b. Chemical

(1) Burning

- (a) Wool and silk - Odor of burning hair
- (b) Cotton, linen, rayon - Odor of burning paper
- (c) Nylon melts

(2) Solubility

- (a) Hydrochloric acid - Wool, cotton, linen unaffected
- (b) Hydrochloric acid - Silk, rayon dissolve
- (c) Sodium hydroxide - Wool, silk dissolve

I. Rubber and plastics

1. Natural rubber

- a. Secured from the Hevea tree
- b. Liquid called latex
- c. Coagulated by heat and smoke or with acetic or formic acid
- d. Composed of isoprene molecules

2. Vulcanization

- a. To make rubber non sticky and firm
- b. Done by adding sulfur
- c. Hardness depends upon amount of sulfur
- d. Color added by various chemicals
- e. Reduces oxidation of rubber

### 3. Synthetic rubber

#### a. Neoprene

- (1) Made from acetylene
- (2) Not affected by oils, heat, light or air

#### b. Buna

- (1) Made from butadiene and styrene
- (2) Sources of butadiene - Alcohol
- (3) Two kinds, Buna - S, and Buna - N
- (4) Resists oil

#### c. Butyl rubber - Will vulcanize

### 4. Plastics

#### a. Rosin and shellac natural plastics

#### b. Usually considered as synthetic

#### c. Thermoplastics - Can be reheated

#### d. Thermosetting - Can not be reheated

## II. Attitude toward:

### A. Application of chemistry to everyday life

### B. Improving your study habits

### C. Chemistry as a benefactor of man

### D. Respect for accurate work

### E. Respect for neat work

## III. Habit of:

### A. Reading current articles on chemistry

### B. Applying chemistry to everyday things

### C. Studying regularly

### D. Performing each laboratory experiment

### E. Doing accurate and neat work

F. Checking work on work sheets

IV. Appreciation for:

- A. Current literature on chemistry
- B. New material developed by chemistry
- C. Laboratory work
- D. Study aids
- E. Neat work
- F. Accurate work
- G. Self-improvement

Leads to Other Units

Carbon

The material learned in this unit should be of use to the student in studying the following units:

- VII. The Periodic Law
- VIII. Non Metals
- IX. Metals

Teacher Evaluation

Carbon

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free informal association of pupils?
3. Provide an opportunity for manipulative activity?
4. Make a coherent whole?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
✓					
	✓				

5. Provide a considerable amount of student activity?
6. Produce satisfying outcomes?
7. Provide sufficient concrete and illustrative materials?
8. Have a useful purpose in the present and future life of the pupils?
9. Reproduce actual life situations as far as possible?
10. Utilize materials as they occur in life?
11. Contain some concrete material?
12. Provide opportunity to pupils to originate, plan, and direct activity as far as possible?
13. Provide opportunity to judge, choose, and evaluate?
14. End lies within the available time?
15. Make it possible for a new teacher to put it in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete, exact references?

Ex.	V.G.	G.	F.	P.	None
		✓			
		✓			
		✓			
		✓			
		✓			
✓					
		✓			
		✓			
✓					
	✓				
✓					
✓					



## Pupil Test

## Knowledge Test

## Carbon

Mark the following statements true with a plus (+) sign or a zero (0) sign for false.

- \_\_\_ 1. Natural diamonds are usually found in regions of volcanic activity.
- \_\_\_ 2. Diamonds are the purest form of carbon.
- \_\_\_ 3. Diamonds owe their brilliance to reflected light.
- \_\_\_ 4. Most of the diamonds are used in industrial work.
- \_\_\_ 5. The chief use of graphite is in the making of pencil lead.
- \_\_\_ 6. Carborundum is composed of silicon and graphite.
- \_\_\_ 7. Charcoal is pure carbon.
- \_\_\_ 8. Coke is made by the destructive distillation of coal.
- \_\_\_ 9. Carbon is a good oxidizing agent.
- \_\_\_ 10. Carbon monoxide is a poisonous gas.
- \_\_\_ 11. Carbon dioxide is an odorless gas.
- \_\_\_ 12. Heating a carbonate will produce carbon monoxide.
- \_\_\_ 13. Baking powders give off carbon dioxide when heated.
- \_\_\_ 14. Green plants use oxygen in making sugar.
- \_\_\_ 15. Only green plants can make their own foods.
- \_\_\_ 16. Natural gas is composed of methane as the principal chemical.
- \_\_\_ 17. All fuels have the same heat value per pound.
- \_\_\_ 18. Lignite is made from peat.
- \_\_\_ 19. Foods are organic compounds.
- \_\_\_ 20. Carbon forms compounds by sharing electrons.
- \_\_\_ 21. We use structural formulas for organic compounds because more than one may have the same empirical formula.

- \_\_\_\_\_ 22. All organic compounds are insoluble in water.
- \_\_\_\_\_ 23. None of the organic compounds ionize in solution.
- \_\_\_\_\_ 24. Methanol is obtained from coal.
- \_\_\_\_\_ 25. Petroleum is a compound of carbon and hydrogen.
- \_\_\_\_\_ 26. Hydrocarbons contain only carbon and hydrogen.
- \_\_\_\_\_ 27. All alcohols contain an hydroxyl group.
- \_\_\_\_\_ 28. Methanol has the formula  $C_2H_5OH$ .
- \_\_\_\_\_ 29. Methyl alcohol is poisonous.
- \_\_\_\_\_ 30. Grain alcohol is thought to be a mild stimulant.
- \_\_\_\_\_ 31. Denatured alcohol contains a poison or nauseating substance.
- \_\_\_\_\_ 32. Prestone antifreeze contains an alcohol.
- \_\_\_\_\_ 33. Ether is made from ethanol.
- \_\_\_\_\_ 34. Glycerol is a by-product of soap making.
- \_\_\_\_\_ 35. Sodium soaps are made into cake form.
- \_\_\_\_\_ 36. Monosaccharides include the starches dextrin.
- \_\_\_\_\_ 37. Cane sugar is rich in glucose.
- \_\_\_\_\_ 38. Starch is changed into sucrose by digestion.
- \_\_\_\_\_ 39. Digestion changes glucose into sucrose.
- \_\_\_\_\_ 40. Carbohydrates are the energy producing foods.
- \_\_\_\_\_ 41. Dextrin is formed when bread is toasted.
- \_\_\_\_\_ 42. Fats are changed into amino acids during digestion.
- \_\_\_\_\_ 43. Enzymes are used to bring about chemical digestion.
- \_\_\_\_\_ 44. Proteins are used by the body to supply us with energy.
- \_\_\_\_\_ 45. All proteins contain the element nitrogen.
- \_\_\_\_\_ 46. Vitamins are not used by the body for energy or tissue building.
- \_\_\_\_\_ 47. Vitamin K is essential for blood clotting.
- \_\_\_\_\_ 48. Cocci bacteria are round in shape.

- \_\_\_\_\_ 49. A germicide kills all the bacteria.  
 \_\_\_\_\_ 50. Penicillin is a germicide.  
 \_\_\_\_\_ 51. Alcohol is a narcotic.  
 \_\_\_\_\_ 52. Alcohol is not a food.  
 \_\_\_\_\_ 53. Rubber is a hydrocarbon.  
 \_\_\_\_\_ 54. Vulcanized rubber is made by heating natural rubber.  
 \_\_\_\_\_ 55. Synthetic rubber does not oxidize as readily as natural rubber.  
 \_\_\_\_\_ 56. Neoprene is made from acetylene.  
 \_\_\_\_\_ 57. All plastics are synthetic compounds.  
 \_\_\_\_\_ 58. Thermoplastics cannot be remolded once they have hardened.  
 \_\_\_\_\_ 59. Bakelite is a thermosetting plastic.  
 \_\_\_\_\_ 60. Vinyl resins will not burn.

## Key to Knowledge Test

## Carbon

1. +	13. +	25. 0	37. 0	49. +
2. +	14. 0	26. +	38. 0	50. +
3. 0	15. +	27. +	39. 0	51. +
4. +	16. +	28. 0	40. +	52. +
5. 0	17. 0	29. +	41. +	53. +
6. +	18. +	30. 0	42. 0	54. 0
7. 0	19. +	31. +	43. +	55. +
8. +	20. +	32. +	44. 0	56. +
9. 0	21. +	33. +	45. +	57. 0
10. +	22. 0	34. +	46. +	58. 0
11. +	23. 0	35. +	47. +	59. +
12. +	24. +	36. 0	48. +	60. +

## Pupil Test

## Attitude Test

## Carbon

Answer yes or no.

- \_\_\_\_\_ 1. Do you have a greater appreciation for chemistry?
- \_\_\_\_\_ 2. Do you enjoy studying chemistry?
- \_\_\_\_\_ 3. Do you enjoy laboratory work?
- \_\_\_\_\_ 4. Do you find current articles on chemistry interesting?
- \_\_\_\_\_ 5. Do you like to use study guides?
- \_\_\_\_\_ 6. Do you like to use the work sheets?
- \_\_\_\_\_ 7. Do you make practical application of your knowledge of chemistry?
- \_\_\_\_\_ 8. Do you feel that studying chemistry has helped you?
- \_\_\_\_\_ 9. Do you appreciate daily assignments?
- \_\_\_\_\_ 10. Is it an aid to keep your equipment clean?
- \_\_\_\_\_ 11. Is it an aid to keep the chemicals in a definite place?
- \_\_\_\_\_ 12. Are good study habits an aid to you?
- \_\_\_\_\_ 13. Do you like doing individual work?
- \_\_\_\_\_ 14. Are you ready to continue the study in the next unit?
- \_\_\_\_\_ 15. Is the work in chemistry too hard for you?

## Pupil Test

## Habit Test

## Carbon

Answer yes or no.

- \_\_\_\_\_ 1. Do you study each chemistry assignment?
- \_\_\_\_\_ 2. Do you have a regular time to study chemistry?
- \_\_\_\_\_ 3. Do you read current news articles on chemistry?
- \_\_\_\_\_ 4. Do you try to make practical use of your knowledge of chemistry?

- \_\_\_\_\_ 5. Do you complete all experiments?
- \_\_\_\_\_ 6. Do you accurately perform all chemistry experiments?
- \_\_\_\_\_ 7. Do you put all your equipment away after using it?
- \_\_\_\_\_ 8. Do you read the experiment before starting?
- \_\_\_\_\_ 9. Do you use your study aids?
- \_\_\_\_\_ 10. Do you use the work sheets?
- \_\_\_\_\_ 11. Are you doing your best?
- \_\_\_\_\_ 12. Do you strive to do better work?
- \_\_\_\_\_ 13. Do you tell other students how "hard" chemistry is?
- \_\_\_\_\_ 14. Do you use only the amounts of chemical needed in the laboratory?
- \_\_\_\_\_ 15. Do you keep your equipment clean?

Key to Habit Test

Carbon

A desirable answer would be yes for all questions except number 13.

Pupil Test

Appreciation Test

Carbon

Answer yes or no.

- \_\_\_\_\_ 1. Do you appreciate your study of chemistry?
- \_\_\_\_\_ 2. Do you appreciate the new materials made possible by chemistry?
- \_\_\_\_\_ 3. Do you appreciate how chemistry has aided in combatting diseases?
- \_\_\_\_\_ 4. Do you appreciate current news articles on chemistry?
- \_\_\_\_\_ 5. Do you appreciate the exactness of chemistry?
- \_\_\_\_\_ 6. Do you appreciate the study of plastics?
- \_\_\_\_\_ 7. Do you appreciate your study guides?
- \_\_\_\_\_ 8. Do you appreciate your knowledge of chemistry?
- \_\_\_\_\_ 9. Do you appreciate good study habits?

\_\_\_\_\_ 10. Do you appreciate your laboratory equipment?

Key to Appreciation Test

Carbon

A desirable answer would be yes to all questions.

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Carbon

Teacher

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## Unit No. VII

## The Periodic Law and Chemical Families

In your study of acids, bases, and salts you found that compounds in each classification react very much alike chemically. Elements may also be classified - placed in groups - since there are a number of elements with similar properties. The ninety odd elements are generally placed in nine such groups in accord with their properties and outer orbital structure. After learning the properties of one element in a group you know many of the characteristics of the other elements of this group.

The elements in certain groups have properties which are so much alike that they are referred to as a family. In this study, we shall study in detail the family composed of fluorine, chlorine, bromine, and iodine, as well as the nitrogen, phosphorus, arsenic, antimony, and bismuth family.<sup>17</sup>

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#### Criteria for Evaluation of a Unit <sup>18</sup>

##### The Periodic Law and Chemical Families

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal association of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.

<sup>18</sup>

Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.

8. The unit of work should have a useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupils to originate, plan, and direct activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - Fifteen days

Central Theme - A Group Picture

### Objectives

#### The Periodic Law and Chemical Families

- A. Knowledge and understanding of:
  1. Classification of elements
  2. The halogen family
  3. The nitrogen family
- B. Attitude toward:
  1. Organization aids learning
  2. Benefits of the periodic chart
  3. Grouping of the elements as an aid
  4. Good study habits

5. Accurate work
6. Knowledge of chemistry aids man
7. Limitations of periodic chart

C. Habit of:

1. Organizing your work
2. Doing accurate work
3. Studying regularly
4. Grouping the elements
5. Determining properties of elements from periodic chart
6. Associating one element with other elements
7. Using the study aids
8. Doing individual work

D. Appreciation for:

1. The periodic chart
2. The grouping of elements
3. Good study habits
4. Organization of work
5. Organization of material
6. Similarity of elements
7. Laboratory work

### Approaches

#### The Periodic Law and Chemical Families

In this unit, we shall study how a classification of the elements was worked out. Then we shall see how it is possible to know some of the properties of all the elements in each group by knowing the properties of one of them.

## Study Guide No. I

## Classification of Elements

- A. Discussion of Prout's classification of elements
- B. Discussion of Newland's classification of elements
- C. Outling the work of Mendeleef
- D. Listing the values of the Periodic Table
- E. Discussing significance of periods
- F. Discussing meaning of families in periodic chart
- G. Listing of weaknesses of Periodic Table

## References

- Rawlins - Struble, Chemistry in Action, pp. 363-370.
- Biddle - Bush, Chemistry Today, pp. 182-191.

## Subject Matter No. I

## Classification of Elements

- I. Development of Periodic Table
  - A. Prout - Atomic weights
  - B. Newland - Atomic weights
  - C. Mendeleef - Atomic weights
  - D. Moseley - Atomic numbers
- II. Values of Periodic Table
  - A. Similarity of elements
  - B. Valence
  - C. Discovery of new elements
- III. Significance of periods
- IV. Significance of families
- V. Numbers on the Periodic Table
- VI. Weaknesses of Periodic Table

## Activities No. I

## Classification of Elements

- A. Answering questions on p. 370 of Rawlins - Struble, Chemistry in Action
- B. Presentation and discussion of a large Periodic Table

## Correlations No. I

## Classification of Elements

- A. Reading - Specific references
- B. Writing - Answering assigned questions

## Work Sheet No. I

## Classification of Elements

Mark the following statements true with a plus (+) sign or false with a zero (0) sign.

- \_\_\_\_\_ 1. Prout classified the elements in relation to hydrogens' atomic weight.
- \_\_\_\_\_ 2. Newland started his classification with lithium.
- \_\_\_\_\_ 3. Newland was the first to suggest the period arrangement.
- \_\_\_\_\_ 4. Mendeleef arranged the elements in the order of their atomic weights.
- \_\_\_\_\_ 5. Moseley arranged his periodic chart of elements in the order of the atomic members.
- \_\_\_\_\_ 6. The elements in the periodic chart of today is arranged in the order of the atomic weights.
- \_\_\_\_\_ 7. All the elements of group I are inert.
- \_\_\_\_\_ 8. All the elements in period II are alike in chemical properties.
- \_\_\_\_\_ 9. The group an element is in also denotes its common valence.
- \_\_\_\_\_ 10. Each period begins with a very active element.
- \_\_\_\_\_ 11. Elements in a group resemble each other more closely than those in a family.

- \_\_\_\_\_ 12. The group an element is in also denotes the number of electrons in outer orbit.
- \_\_\_\_\_ 13. Most of the elements to the right of the diagonal line in the chart are non-metals.
- \_\_\_\_\_ 14. Sodium is similar to potassium in chemical activity.
- \_\_\_\_\_ 15. The smaller numbers with element is its atomic weight.
- \_\_\_\_\_ 16. The periodic chart gives the most common valence in all cases.
- \_\_\_\_\_ 17. The periodic chart only shows one valence.
- \_\_\_\_\_ 18. Hydrogen is a metal in its chemical behavior.
- \_\_\_\_\_ 19. All the elements in group VIII are very active elements.
- \_\_\_\_\_ 20. All the elements in group 0 are inert

#### Key to Work Sheet No. I

#### Classification of Elements

1. +	5. +	9. 0	13. +	17. +
2. +	6. 0	10. 0	14. +	18. +
3. +	7. 0	11. 0	15. 0	19. 0
4. +	8. 0	12. +	16. 0	20. +

#### Study Guide No. II

#### The Halogen Family

- A. Listing elements in halogen family
- B. List of properties of halogens
- C. Definition of heat of formation of compound
- D. List of uses of fluorine and fluorides
- E. Discussion of chemical activity of fluorine
- F. Discussion of preparation of hydrogen fluoride
- G. Discussion of uses of chlorine in chemical warfare
- H. List of chemical properties of chlorine

- I. Discussion of preparation of chlorine
- J. Discussion of preparation of chemical properties of hydrogen chloride
- K. List of uses of hydrochloric acid
- L. Description of test for chloride
- M. Discussion of bromine as to its uses, sources, properties, preparation, test for
- N. Discussion of iodine as to its uses, sources, preparation, and test for

#### References

Foster, The Romance of Chemistry, pp. 111-128.

Rawlins - Struble, Chemistry in Action, pp. 371-390.

#### Subject Matter No. II

##### Halogens

- I. Halogen family
  - A. Chlorine
  - B. Fluorine
  - C. Bromine
  - D. Iodine
  - E. Properties of
  - F. Heat of formation of a compound
- II. Fluorine
  - A. Uses of
    - 1. Fluorine
    - 2. Fluorides
  - B. Chemical activity
  - C. Formation of hydrogen fluoride
  - D. Fluorine in the human body
  - E. Test for fluorides

### III. Chlorine

- A. Gases used in chemical warfare
  - 1. Lung irritants
  - 2. Vesicants
  - 3. Lachrymators
- B. Uses of
- C. Chemical activity
- D. Properties of
  - 1. Chemical
  - 2. Physical
- E. Preparation of
- F. Formation of hydrogen chloride
- G. Formation of hydrochloric acid
- H. Uses of hydrochloric acid
- I. Chemical properties of HCl
- J. Test for chlorides

### IV. Bromine

- A. Uses of
- B. Sources of
- C. Preparation of
  - 1. Commercial
  - 2. Laboratory
- D. Test for
- E. Comparison of test with bromine, chlorine

### Activities No. II

#### Halogens

- A. Preparation of chlorine, bromine, iodine in laboratory



- B. Preparation of hydrochloric acid in laboratory
- C. Testing for fluorine, chlorine, bromine, iodine in laboratory

## Correlations No. II

## Halogens

- A. Reading - Specific references
- B. Writing - Laboratory experiments
- C. Spelling - New terms such as fluorides, bromine, hydrochloric acid, vesicants, lachrymators, phosgene, lewisite
- D. History - Uses of chemicals in World War I and II

## Work Sheet No. II

## Halogens

Mark the following statements true with a plus (+) sign and false with a zero (0) sign.

- \_\_\_\_\_ 1. All the halogens have a valence of +1.
- \_\_\_\_\_ 2. Fluorine is the most active of the halogens.
- \_\_\_\_\_ 3. The higher the atomic number the more chemically active is the halogen.
- \_\_\_\_\_ 4. Compounds with a high positive heat of formation are stable.
- \_\_\_\_\_ 5. Hydrogen fluoride cannot be stored in glass containers.
- \_\_\_\_\_ 6. Hydrogen fluoride is used in the etching of glass.
- \_\_\_\_\_ 7. Fluorine is the most active of the non-metals.
- \_\_\_\_\_ 8. Small amounts of fluorine in drinking water causes discolored teeth.
- \_\_\_\_\_ 9. Phosgene is a gas used as a vesicant in chemical warfare.
- \_\_\_\_\_ 10. Lachrymators irritate the eyes and renders the person helpless.
- \_\_\_\_\_ 11. Vesicants cause an irritation of the lungs.
- \_\_\_\_\_ 12. Lewisite is a vesicant.

- \_\_\_\_\_ 13. Chlorine is a pale yellowish green gas.
- \_\_\_\_\_ 14. Chlorine is a good bleaching agent.
- \_\_\_\_\_ 15. Chlorine is capable of supporting combustion.
- \_\_\_\_\_ 16. Chlorine gas is nearly insoluble in water.
- \_\_\_\_\_ 17. The chlorine ion has a positive valence.
- \_\_\_\_\_ 18. Dry gaseous hydrogen chloride is an active compound of chlorine.
- \_\_\_\_\_ 19. Silver chloride is soluble in water.
- \_\_\_\_\_ 20. Bromine is a reddish brown liquid.
- \_\_\_\_\_ 21. Chlorine will displace bromine from its compounds.
- \_\_\_\_\_ 22. Iodine is a solid.
- \_\_\_\_\_ 23. Iodine is the least active of the halogens.
- \_\_\_\_\_ 24. Silver iodine is a bright yellow compound.

Complete the following statements.

- 1. Two lung irritants used in chemical warfare are a. \_\_\_\_\_  
b. \_\_\_\_\_.
- 2. A \_\_\_\_\_ produces very painful burns on contact with the body.
- 3. Two peace time uses of chlorine are a. \_\_\_\_\_ b. \_\_\_\_\_.
- 4. Chlorine is prepared by heating a mixture of \_\_\_\_\_ and \_\_\_\_\_.
- 5. Hydrogen chloride is prepared by heating a mixture of \_\_\_\_\_ and \_\_\_\_\_.
- 6. \_\_\_\_\_ added to a chloride solution causes a white precipitate to form.
- 7. Chlorine can replace both \_\_\_\_\_ and \_\_\_\_\_ from their compounds.
- 8. \_\_\_\_\_ is used to prevent the disease goiter.

9. \_\_\_\_\_ is used to purify water by killing the germs.
10. Tincture of iodine is usually sold as a \_\_\_\_\_ per cent alcohol solution.

## Key to Work Sheet No. II

## Halogens

## True and false

- |      |       |       |       |       |
|------|-------|-------|-------|-------|
| 1. 0 | 6. +  | 11. 0 | 16. 0 | 21. + |
| 2. + | 7. +  | 12. + | 17. 0 | 22. + |
| 3. 0 | 8. 0  | 13. + | 18. 0 | 23. + |
| 4. + | 9. 0  | 14. + | 19. 0 | 24. + |
| 5. + | 10. + | 15. + | 20. + |       |

## Completion

1. (a) phosgene (b) chloropicrin
2. Vesicant
3. Bleaching agent, germicide
4. Hydrogen chloride and manganese dioxide
5. Sodium chloride and sulfuric acid
6. Silver nitrate
7. Bromine, iodine
8. Iodine
9. Chlorine
10. 2

## Study Guide No. III

## Nitrogen Family

- A. Discussion on the early and present fire starting devices
- B. Description of the construction of matches
- C. Discussion of uses of phosphorus and phosphorus compounds

- D. Discussion of uses of phosphorus and phosphorus compounds
- E. Discussion of the use of fertilizers
- F. List of uses made of arsenic
- G. Discussion of uses of insecticides
- H. List of members of nitrogen family

#### References

- Rawlins - Struble, Chemistry in Action, pp. 390-407.  
Foster, The Romance of Chemistry, pp. 204-217.  
Arhens, Bush, Easley, Living Chemistry, pp. 430-443.

#### Subject Matter No. III

##### Nitrogen Family

#### I. Phosphorus

- A. History of fire
- B. Match
  - 1. Invention of
  - 2. Friction match
  - 3. Safety match
- C. Allotropic forms of
  - 1. Chemical properties
  - 2. Physical properties
- D. Occurrence of
- E. Acids of
- F. Fertilizers
  - 1. History of
  - 2. Types of
  - 3. Composition of

#### II. Potassium

### III. Arsenic

- A. Uses of
- B. Properties of
  - 1. Physical
  - 2. Chemical
- C. Test for
- D. Insecticides
  - 1. Chewing insects
  - 2. Sucking insects

### IV. Antimony

- A. Sources
- B. Uses of

### V. Bismuth

- A. Properties of
  - 1. Chemical
  - 2. Physical
- B. Uses of

### Activities No. III

#### Nitrogen Family

- A. Laboratory experiment on the properties of phosphorus
- B. Laboratory test for arsenic

### Correlations No. III

#### Nitrogen Family

- A. Biology - Study of insects and insecticides
- B. Reading - Specific references
- C. Agriculture - Study of fertilizers
- D. Health - Use of insecticides

## Work Sheet No. III

## Nitrogen Family

Complete the following statements:

1. The head of a "strike-anywhere" match usually contains a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_ d. \_\_\_\_\_.
2. The head of the safety match lacks \_\_\_\_\_ in its construction.
3. Two allotropic forms of phosphorus are a. \_\_\_\_\_ b. \_\_\_\_\_.
4. Phosphorus burns in air to form \_\_\_\_\_.
5. Two important acids of phosphorus are a. \_\_\_\_\_ b. \_\_\_\_\_.
6. The big three elements in commercial fertilizers are a. \_\_\_\_\_  
b. \_\_\_\_\_.
7. The expression "4-9-5" on a fertilizer bag denotes what composition  
a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_.
8. Two common acids of arsenic are a. \_\_\_\_\_ b. \_\_\_\_\_.
9. \_\_\_\_\_ insects are killed by the use of a stomach poison.
10. Three common stomach poisons are a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_.
11. \_\_\_\_\_ insects must be killed by poisons of the body  
contact type.
12. Black Leaf 40 contains the poison \_\_\_\_\_.
13. D.D.T. is effective against the \_\_\_\_\_ type insect.
14. Bordeaux mixture contains \_\_\_\_\_ and \_\_\_\_\_.
15. Alloy of \_\_\_\_\_ is used in automatic fire sprinklers.
16. The ore containing antimony is called \_\_\_\_\_.
17. Antimony alloys are used in making automobile \_\_\_\_\_.
18. \_\_\_\_\_ is an alloy of antimony.
19. \_\_\_\_\_ salts are used in making X-rays of the digestive

system.

20. \_\_\_\_\_ are effective against fungi infections of plants.

#### Key to Work Sheet No. III

#### Nitrogen Family

1. Glue, ground glass, potassium chlorate, phosphorus trisulfide
2. Phosphorus compound
3. White, yellow
4. Phosphorus pentoxide
5. Phosphorous, phosphoric
6. Nitrogen, phosphorus, potassium
7. 4% nitrogen, 9% phosphorus, 5% potassium
8. Arsenious, arsenic
9. Chewing
10. Cryolite, Rotenone, Paris green, Lead arsenate, Calcium arsenate
11. Sucking
12. Nicotine
13. Sucking
14. Copper sulfate, slacked lime
15. Bismuth
16. Stibnite
17. Bearings
18. Babbit
19. Bismuth
20. Fungicides

#### Culminating Activities

#### The Periodic Law and Chemical Families

- I. Visiting local water purification plant to learn uses of chlorine and fluorine

- II. Testing of samples of garden soil
- III. Visiting local health department and discussing control of insects

Desirable Outcomes

The Periodic Law and Chemical Families

I. Knowledge and Understanding of:

A. Classification of elements

1. History of

- a. Prout - All matter composed of multiples of the simple element hydrogen
- b. Newland - The elements in the order of their increasing atomic weights
- c. Mendeleef
  - (1) Developed first periodic chart
  - (2) Arranged elements in order of increasing atomic weights
  - (3) Stimulated research to find missing elements in his table
- d. Moseley - Elements in the order of their increasing atomic numbers

2. Periodic Table

a. Values of

- (1) Simplifies study of elements
- (2) Groups elements by similarities
- (3) Groups elements into families
- (4) Indicates valence
- (5) Indicates chemical activity
- (6) Stimulated professional research
- (7) Places elements in periods
- (8) Starts each period with an inactive element



b. Weaknesses of

- (1) Gives only one valence
- (2) Does not always give common valence
- (3) No satisfactory place for hydrogen

B. Halogen: family

1. Members are

- a. Fluorine
- b. Chlorine
- c. Bromine
- d. Iodine

2. Properties of

- a. Seven electrons in outer orbit
- b. Valence - 1
- c. Salts known as
  - (1) Fluorides
  - (2) Chlorides
  - (3) Bromides
  - (4) Iodides
- d. Heat of formation of compounds
  - (1) Given off during formation
  - (2) Taken on during formation

3. Fluorine

- a. Most active non-metal
- b. Used in etching of glass
- c. Valence of -1
- d. Hydrogen fluoride
  - (1) Obtained from calcium fluoride and sulfuric acid

- (2) Heating potassium hydrogen fluoride
- (3) Dissolves in water to form hydrofluoric acid
- (4) Stored in paraffin containers

- e. Teeth contain small amounts
- f. Used to prevent tooth decay

4. Chlorine

- a. Component of chemical warfare gases
- b. Lung irritants - effects the lungs
  - (1) Phosgene
  - (2) Chloropicrin
- c. Vesicants - burns the body tissues
  - (1) Mustard gas
  - (2) Lewisite
- d. Lachrymators - affects the eyes
- e. Peace time uses
  - (1) Bleaching powder
  - (2) Germicide
- f. Properties of
  - (1) Chemical
    - (a) Bleaching agent
    - (b) Supports combustion
  - (2) Physical
    - (a) Liquid at ordinary temperature
    - (b) Poisonous gas
    - (c) Yellowish green color
    - (d) Irritating odor

g. Preparation of

- (1) Heating of hydrochloric acid and manganese dioxide
- (2) Heating of sodium chloride, sulfuric acid, and manganese dioxide

h. Hydrogen chloride

(1) Preparation

- (a) Heating of sodium chloride
- (b) Direct combining of hydrogen and chlorine

i. Hydrochloric acid

- (1) Dissolved hydrogen chloride in water
- (2) Ionizes freely
- (3) Replaces hydrogen with metals above copper
- (4) Reacts with bases to form salts

j. Test for chlorides

- (1) Addition of silver nitrate to solution
- (2) Formation of white precipitate
- (3) Insoluble in nitric acid

5. Bromine

a. Uses of

- (1) Making antiknock gasoline
- (2) Salts in medicines
- (3) Making photographic film
- (4) Tear gases

b. Sources

- (1) Does not occur free in nature
- (2) Obtained from sea water
- (3) Secured by replacement from compounds by chlorine

c. Properties of

(1) Physical

- (a) Dark red in color
- (b) Liquid at ordinary temperature

(2) Chemical

- (a) Valence - 1
- (b) Moderate in activity
- (c) Corrosive

d. Preparation of - Heating of potassium bromide, sulfuric acid, and manganese dioxide

e. Test for

- (1) Add solution of salt to carbon tetrachloride
- (2) Pass free chlorine into mixture
- (3) Bromine - Red bead with carbon tetrachloride

6. Iodine

a. Uses of

- (1) To prevent goiter
- (2) Germicide
- (3) Making iodoform

b. Sources

- (1) Does not exist as free iodine
- (2) Obtained from seaweeds
- (3) Obtained from sodium iodate

e. Preparation

- (1) Heating mixture of potassium iodide, sulfuric acid, and manganese dioxide

d. Test for

- (1) Mix solution of salt and carbon-tetrachloride
- (2) Pass free chlorine into mixture
- (3) Iodine - Violet bead with carbon-tetrachloride

C. Nitrogen family

1. Members include

- a. Phosphorus
- b. Arsenic
- c. Antimony
- d. Bismuth
- e. Nitrogen

2. Phosphorus

a. Matches

(1) "Strike anywhere"

- (a) Paraffin dipped wood stick
- (b) Head composition - glue, glass, potassium chlorate, phosphorus trisulfide
- (c) Colored for attraction

(2) Safety match

- (a) Same construction as strike anywhere except phosphorus compound left out
- (b) Striking surface composed of
  - (1) Red phosphorus
  - (2) Antimony sulfide
  - (c) Abrasive

b. Allotropic forms

- (1) White
- (2) Yellow

c. Properties of

- (1) Ignites easily
- (2) Produces serious burns
- (3) Burns in air to form  $P_2O_5$

d. Sources - tissues of organisms

e. Acids of

- (1) Phosphorous,  $H_3PO_3$
- (2) Phosphoric,  $H_3PO_4$

f. Fertilizers

- (1) Commercial fertilizers contain
  - (a) Nitrogen
  - (b) Phosphorus
  - (c) Potassium
  - (d) Amounts designated by numbers such as 4-5-5

3. Potassium - Not a member of nitrogen family but in all fertilizers

4. Arsenic

a. Uses

- (1) Making alloys
- (2) Making insecticides

b. Properties of

- (1) Physical
  - (a) Resembles metals
  - (b) Brittle, gray solid
- (2) Chemical
  - (a) Non-metal
  - (b) Forms acids
  - (c) Valence - 3

c. Insecticides

(1) Chewing insects

- (a) Affects digestive system
- (b) Use a dust or spray
- (c) Rotenone
- (d) Paris green - copper salt
- (e) Lead arsenate - lead salt
- (f) Calcium arsenate - calcium salt

(2) Sucking insects

- (a) Poisons of body contact type
- (b) D.D.T.
- (c) Black Leaf 40

5. Antimony

a. Extracted from stibnite

b. Used in making alloys

- (1) Babbit
- (2) Britannia
- (3) Type metal

6. Bismuth

a. Low melting point

b. Used in making automatic fire sprinklers

c. Salts in medicine

II. Attitude toward:

- A. Organization as an aid to work
- B. Study of Periodic Table as an aid to study of chemistry
- C. Periodic Table's simplification of a study of the elements
- D. The importance of the halogens to man

- E. Chemistry's improvement of the life of man
- F. Reading scientific articles as a worth while project
- G. The nitrogen family's importance to man
- H. Understanding things around us through chemistry
- I. Good study habits
- J. Neat work

III. Habit of:

- A. Using the Periodic Table
- B. Organizing your work
- C. Using your study guides
- D. Checking your self with the work sheets
- E. Doing neat work
- F. Associating chemistry with things about you
- G. Reading scientific articles in newspapers and magazines
- H. Applying your knowledge of chemistry wherever possible

IV. Appreciation for:

- A. An understanding of the Periodic Table
- B. The work of developing the Periodic Table
- C. Chemistry and the controls of insects
- D. Chemistry and soil fertility
- E. Understanding of insecticides
- F. Understanding of fertilizers
- G. Neat work
- H. Chemistry and its aids to man



## Leads to Other Units

## The Periodic Law and Chemical Families

Since chemistry is thought of as a continuous subject, the students knowledge gained in the past study should help him to understand the following units.

VIII. Some Important Non-metals

IX. The Metals

## Teacher Evaluation

## The Periodic Law and Chemical Families

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free informal association of pupils?
3. Provide an opportunity for manipulative activity?
4. Make a coherent whole?
5. Provide a considerable amount of student activity?
6. Produce satisfying outcomes?
7. Provide sufficient concrete and illustrative material?
8. Have a useful purpose in the present and future life of the pupils?
9. Reproduce actual life situations as far as possible?

Ex.	V.G.	G.	F.	P.	None
✓					
✓					
✓					
		✓			
✓					
		✓			
	✓				
			✓		
			✓		

10. Utilize materials as they occur in life?
11. Contain some accurate material?
12. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?
13. Provide opportunity to judge, choose, and evaluate?
14. End lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete, exact references?

Ex.	V.G.	G.	F.	P.	None
	✓				
	✓				
	✓				
	✓				
✓					
	✓				
✓					
✓					

#### Pupil Test

#### Knowledge Test

#### The Periodic Law and Chemical Families

Complete the following statements:

1. \_\_\_\_\_ was the first man to place the elements in a chart according to their atomic numbers.
2. Elements in \_\_\_\_\_ resemble each other more closely than those in the same group.
3. All the elements in the halogen family have a valence of \_\_\_\_\_.
4. \_\_\_\_\_ is the most active element of the halogen family.
5. \_\_\_\_\_ is the least active element of the halogen family.

6. \_\_\_\_\_ is used in itching glass.
7. Write the equation showing the preparation of hydrogen fluoride.  
\_\_\_\_\_.
8. \_\_\_\_\_ and \_\_\_\_\_ are gases used as lung irritants in chemical warfare.
9. \_\_\_\_\_ and \_\_\_\_\_ are chlorine compounds used as vesicants in chemical warfare.
10. \_\_\_\_\_ effects the eyes and renders the victim helpless.
11. Write the equation for the laboratory preparation of chlorine.  
\_\_\_\_\_.
12. Write the equation for the laboratory preparation of hydrogen chloride.  
\_\_\_\_\_.
13. \_\_\_\_\_ is a halogen used in making anti-knock gasoline.
14. Iodine is useful in preventing the disease \_\_\_\_\_.
15. \_\_\_\_\_ is a compound of iodine used as an antiseptic.
16. Silver chloride is a \_\_\_\_\_ precipitate in testing for chlorides.
17. \_\_\_\_\_ is used in making matches to prevent after glow.
18. \_\_\_\_\_ is used in matches as an abrasive.
19. \_\_\_\_\_ is used as an oxidizing agent in match construction.
20. The three elements most commonly found in commercial fertilizers are  
a. \_\_\_\_\_, b. \_\_\_\_\_, c. \_\_\_\_\_.
21. \_\_\_\_\_ is a poisonous element used in many insecticides.
22. \_\_\_\_\_ is a double salt of copper used in killing insects.
23. \_\_\_\_\_ contains nicotine sulfate.
24. \_\_\_\_\_ is used in making babbitt.
25. \_\_\_\_\_ is used in making automatic sprinkling devices.

Mark the following statements true with a plus (+) sign or false with a zero (0) sign.

- \_\_\_\_\_ 1. All elements in group 0 of the Periodic Table are inert.
- \_\_\_\_\_ 2. Each period of the Periodic Table begins with an inert element.
- \_\_\_\_\_ 3. The group an element is in designates the number of electrons in the outer orbit.
- \_\_\_\_\_ 4. Hydrogen is a non-metal in its chemical behavior.
- \_\_\_\_\_ 5. The periodic chart denotes the common valence for all elements.
- \_\_\_\_\_ 6. All halogens have one electron in the outer orbit.
- \_\_\_\_\_ 7. Fluorine is the most active non-metal.
- \_\_\_\_\_ 8. Small amounts of fluorides in drinking water causes discoloring of the teeth.
- \_\_\_\_\_ 9. Vesicants cause an irritation of the lungs.
- \_\_\_\_\_ 10. Chlorine gas is nearly insoluble in water.
- \_\_\_\_\_ 11. Iodine is a solid with a metallic luster.
- \_\_\_\_\_ 12. Chlorine gas is a good germicide.
- \_\_\_\_\_ 13. Bromine is obtained from sea water.
- \_\_\_\_\_ 14. White phosphorus is stored under water.
- \_\_\_\_\_ 15. White phosphorus cannot be handled with the bare hand.
- \_\_\_\_\_ 16. Red phosphorus can be stored in any type container.
- \_\_\_\_\_ 17. Phosphorus burns in air to form phosphorus trioxide.
- \_\_\_\_\_ 18. The formula for phosphoric acid is  $H_3PO_3$ .
- \_\_\_\_\_ 19. The chewing insect must eat the poison.
- \_\_\_\_\_ 20. Pan's green is used to kill sucking insects.

## Key to Knowledge Test

## The Periodic Law and Chemical Families

## Completion

1. Moseley
2. Families
3. -1
4. Fluorine
5. Iodine
6. Hydrogen Fluoride
7.  $\text{CaF}_2 + \text{H}_2\text{SO}_4 \longrightarrow 2\text{HF} + \text{CaSO}_4$
8. Phosgene, chloropicrin
9. Mustard gas, Lewisite
10. Lachrymators
11.  $2 \text{NaCl} + 3 \text{H}_2\text{SO}_4 + \text{MnO}_2 \longrightarrow 2 \text{NaHSO}_4 + \text{MnSO}_4 + 2\text{H}_2\text{O} + \text{Cl}_2 \uparrow$
12.  $2 \text{NaCl} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO} + 2 \text{HCl} \uparrow$
13. Bromine
14. Goiter
15. Iodoform
16. White
17. Ammonium phosphate
18. Glass or sand
19. Potassium chlorate
20. Nitrogen, phosphorus, potassium
21. Arsenic
22. Paris green
23. Black Leaf 40
24. Antimony
25. Bismuth

## True and false

- |      |       |       |       |
|------|-------|-------|-------|
| 1. + | 6. 0  | 11. + | 16. + |
| 2. + | 7. +  | 12. + | 17. 0 |
| 3. 0 | 8. 0  | 13. + | 18. 0 |
| 4. 0 | 9. 0  | 14. + | 19. + |
| 5. 0 | 10. 0 | 15. + | 20. 0 |

## Pupil Test

## Attitude Test

## The Periodic Law and Chemical Families

Answer yes or no.

- \_\_\_\_\_ 1. Is the Periodic Law of any practical value?
- \_\_\_\_\_ 2. Does the periodic chart help you to understand the different elements?
- \_\_\_\_\_ 3. Will the periodic chart help you in your future study of chemistry?
- \_\_\_\_\_ 4. Does the study of the chlorine family help you to see that elements are similar?
- \_\_\_\_\_ 5. Should we use the periodic chart even though it has a few weak points?
- \_\_\_\_\_ 6. Does chemistry help you to understand things around you?
- \_\_\_\_\_ 7. Are you doing thorough work in the laboratory?
- \_\_\_\_\_ 8. Are you completing all your work?
- \_\_\_\_\_ 9. Does the laboratory work help you to understand chemistry?
- \_\_\_\_\_ 10. Do you have a greater appreciation for chemistry?
- \_\_\_\_\_ 11. Have you received enough help in the class work?
- \_\_\_\_\_ 12. Do you pay attention to the class discussion?
- \_\_\_\_\_ 13. Do the study guides help you in studying chemistry?
- \_\_\_\_\_ 14. Do you like to study chemistry?
- \_\_\_\_\_ 15. Are you working to the best of your ability?

## Pupil Test

## Habit Test

## The Periodic Law and Chemical Families

Answer yes or no.

- \_\_\_\_\_ 1. Do you use your study guides in preparing your lessons?
- \_\_\_\_\_ 2. Do you prepare your lessons each day?
- \_\_\_\_\_ 3. Do you make use of the references that you are referred to?
- \_\_\_\_\_ 4. Do you use the periodic chart?
- \_\_\_\_\_ 5. Do you participate in the classroom activities?
- \_\_\_\_\_ 6. Do you perform each experiment in the laboratory?
- \_\_\_\_\_ 7. Do you do individual work in the laboratory?
- \_\_\_\_\_ 8. Do you read each laboratory experiment before starting the work?
- \_\_\_\_\_ 9. Do you associate chemistry with things around you?
- \_\_\_\_\_ 10. Do you read current articles in newspapers on chemistry?

## Key to Habit Test

## The Periodic Law and Chemical Families

A desirable answer would be yes to all questions.

## Pupil Test

## Appreciation Test

## The Periodic Law and Chemical Families

Answer yes or no.

- \_\_\_\_\_ 1. Do you appreciate the periodic chart?
- \_\_\_\_\_ 2. Do you appreciate the grouping of the elements?
- \_\_\_\_\_ 3. Do you appreciate the work done in developing the periodic chart?
- \_\_\_\_\_ 4. Do you appreciate the study of the halogen family?
- \_\_\_\_\_ 5. Do you appreciate the similarity of the elements?
- \_\_\_\_\_ 6. Do you appreciate the references given you on the topic of discussion?

- \_\_\_\_\_ 7. Do you appreciate the study guides?
- \_\_\_\_\_ 8. Do you appreciate the laboratory work?
- \_\_\_\_\_ 9. Do you appreciate exact work?
- \_\_\_\_\_ 10. Do you appreciate neat work?
- \_\_\_\_\_ 11. Do you appreciate good study habits?
- \_\_\_\_\_ 12. Do you appreciate the opportunity for individual work?
- \_\_\_\_\_ 13. Do you appreciate your new knowledge of chemistry?
- \_\_\_\_\_ 14. Do you appreciate current science articles in magazines?

#### Key to Appreciation Test

#### The Periodic Law and Chemical Families

A desirable answer would be yes to all questions.

#### Bibliography

#### The Periodic Law and Chemical Families

##### Teacher

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##### Pupil

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Foster, William, Romance of Chemistry, (Appleton-Century Company, New York, 1936).

Biddle - Bush, Chemistry Today, (Rand McNally and Company, Chicago, Ill., 1949).

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## Unit No. VIII

## Some Important Non-Metals

In this unit, we will take up a study of three non-metals. These three elements are very important to industry.

Sulfur is useful as a raw material for the production of other chemicals which enter into the manufacture of practically every article of commerce. Undoubtedly the greatest use of sulfur is in the manufacture of sulfuric acid.

Silicon and boron, two other elements discussed are not so familiar. Although it is likely that none of you have ever seen these elements all of you have seen compounds containing them.

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## Some Important Non-Metals

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#### Criteria for Evaluation of a Unit<sup>19</sup>

##### Some Important Non-Metals

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal associations of the pupil.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil.
9. It should reproduce actual life situations.
10. It should utilize materials as they occur in life.

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19. Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.

11. It should contain accurate information.
12. It should provide for opportunity for the pupils to originate, plan, and direct activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. When references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - Ten Days

Central Theme - Non-Metals

#### Objectives

##### Some Important Non-Metals

- A. Knowledge and understanding of:
  1. Sulfur and its compounds
  2. Oxides and acids of sulfur
  3. Glass, other silicates, and boron
- B. Attitude toward:
  1. Importance of chemistry to industry
  2. Importance of sulfur to life
  3. Importance of glass in everyday living
  4. Laboratory experiments as an aid to study
  5. Exact work in laboratory
  6. Neat work
  7. Accurate work
  8. Good study habits

9. Contributions of chemistry to man
  10. Knowledge makes life more pleasant
- C. Habit of:
1. Seeking practical uses of the knowledge of chemistry
  2. Connecting the chemical topic of study with everyday uses
  3. Studying chemistry regularly
  4. Reading laboratory experiments before starting to work
  5. Associating laboratory work with the class discussions
  6. Working until correct results are obtained
  7. Being thorough in the laboratory work
  8. Understanding the commercial uses of chemistry
  9. Using your check sheets
  10. Using your study guides
- D. Appreciation for:
1. An understanding of chemistry
  2. Laboratory experiments
  3. Chemistry and its contributions to everyday living
  4. Good study habits
  5. Exact work
  6. Neat work
  7. Sulfur and its uses in life
  8. Glass and its uses
  9. Good equipment in laboratory

#### Approaches

#### Some Important Non-Metals

This unit may be effectively introduced by showing the film "Sulfur" obtained from U. S. Department of Interior, Bureau of Mines Experiment

Station, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

Study Guide No. I

Sulfur and Its Compounds

- A. Description of method of obtaining sulfur
- B. Description of allotropic forms of sulfur
- C. List of chemical properties of sulfur
- D. List of uses of sulfur
- E. Description of preparation of hydrogen sulfide
- F. Discussion of action of hydrogen sulfide with oxygen
- G. Working problems in Rawlins - Struble, Chemistry in Action, p. 419

References

- Rawlins - Struble, Chemistry in Action, pp. 412-419.
- Foster, The Romance of Chemistry, pp. 184-186.
- Jaffe, New World of Chemistry, pp. 295-307.

Subject Matter No. I

Sulfur and Its Compounds

- I. Sources of
  - A. Deposits
  - B. Mining of
    - 1. Open mining
    - 2. Frasch process
- II. Allotropic forms
  - A. Rhombic
  - B. Monoclinic
    - 1. Preparation
    - 2. Characteristics
  - C. Amorphous

1. Preparation
2. Characteristics

III. Chemical properties

- A. Action with metals
- B. Action with oxygen

IV. Uses of

V. Sulfides

- A. Hydrogen sulfide
  1. Preparation of
  2. Properties of
  3. Uses of
- B. Other sulfides
  1. Metal sulfides
  2. Carbon disulfide

Activities No. I

Sulfur and Its Compounds

- A. Preparation of  $H_2S$
- B. Action of  $H_2S$  on metal salts

Correlations No. I

Sulfur and Its Compounds

- A. Reading - Specific references
- B. Spelling - New terms such as rhombic, amorphous, monoclinic, sulfide
- C. Mathematics - Chemical problems

Work Sheet No. I

Sulfur and Its Compounds

Mark the following statements true or false, using the plus (+) sign for true and the (0) sign for false.

- \_\_\_\_\_ 1. Most of the sulfides are soluble in water.
- \_\_\_\_\_ 2. Hydrogen sulfide is a poisonous gas.
- \_\_\_\_\_ 3. Sulfuric acid is made by dissolving hydrogen sulfide in water.
- \_\_\_\_\_ 4. Iron sulfide was used to prepare hydrogen sulfide.
- \_\_\_\_\_ 5. Decaying proteins produce hydrogen sulfide.
- \_\_\_\_\_ 6. Silver tarnish is due to a sulfide.
- \_\_\_\_\_ 7. Sulfur has a valence of -2.
- \_\_\_\_\_ 8. Sulfur reacts with metals to produce sulfides.
- \_\_\_\_\_ 9. Rhombic sulfur is unstable.
- \_\_\_\_\_ 10. Sulfur is insoluble in water.
- \_\_\_\_\_ 11. Amorphous sulfur is crystalline in structure.
- \_\_\_\_\_ 12. Prismatic sulfur is the only stable form of sulfur.
- \_\_\_\_\_ 13. Flowers of sulfur is a pure form of sulfur.
- \_\_\_\_\_ 14. Most of the sulfur obtained in the United States is mined like coal.
- \_\_\_\_\_ 15. Most of the sulfur is obtained from Sicily.

Complete the following equations

1.  $\text{Mg} + \text{O}_2 \longrightarrow$
2.  $\text{Al} + \text{S} \longrightarrow$
3.  $\text{Zn} + \text{S} \longrightarrow$
4.  $\text{HCl} + \text{FeS} \longrightarrow$
5.  $\text{H}_2\text{S} + \text{O}_2 \longrightarrow$

Solve the following problems

1. How many liter of  $\text{SO}_2$  are produced by burning 32 grams of sulfur?
2. Find the per cent of sulfur in  $\text{H}_2\text{S}$ ,  $\text{SO}_2$  and  $\text{SO}_3$ .
3. How many pounds of zinc sulfide are produced by the use of 100 pounds of sulfur?



## Key to Work Sheet No. I

## Sulfur and Its Compounds

## True and false

- |      |       |       |
|------|-------|-------|
| 1. 0 | 6. +  | 11. 0 |
| 2. + | 7. 0  | 12. 0 |
| 3. 0 | 8. 0  | 13. + |
| 4. + | 9. 0  | 14. 0 |
| 5. + | 10. + | 15. 0 |

## Equations

- $2 \text{ Mg} + \text{O}_2 \longrightarrow 2 \text{ MgO}$
- $2 \text{ Al} + 3 \text{ S} \longrightarrow \text{Al}_2\text{S}_3$
- $\text{Zn} + \text{S} \longrightarrow \text{ZnS}$
- $2 \text{ HCl} + \text{FeS} \longrightarrow \text{H}_2\text{S} + \text{FeCl}_2$
- $2 \text{ H}_2\text{S} + 3 \text{ O}_2 \longrightarrow 2 \text{ H}_2\text{O} + 2 \text{ SO}_2$

## Problems

- 22.4
- $\text{H}_2\text{S} - 94\% \text{ S}, \text{ SO}_2 - 50\% \text{ S}, \text{ SO}_3 - 40\% \text{ S}$
- 303 lbs.

## Study Guide No. II

## Oxides and Acids of Sulfur

- List of ways of preparing sulfur dioxide
- Description of each method of preparation
- Writing equations for each preparation
- List of physical properties of sulfur dioxide
- Discussion of chemical properties of sulfur dioxide
- List of uses of sulfur dioxide
- List of two ways of preparing sulfuric acid

- H. Description of each method of preparation
- I. Discussion of chemical activity of sulfuric acid
- J. Listing uses made of sulfuric acid

#### References

- Rawlins - Struble, Chemistry in Action, pp. 419-427.  
Jaffe, New World of Chemistry, pp. 310-325.  
Foster, The Romance of Chemistry, pp. 180-184.

#### Subject Matter No. II

#### Oxides and Acids of Sulfur

- I. Sulfur dioxide
  - A. Preparation
    - 1. Burning of sulfur
    - 2. Reduction of sulfuric acid
    - 3. Acids on sulfites
  - B. Properties of
    - 1. Physical
    - 2. Chemical
      - a. Action with bases
      - b. Action with water
  - C. Use of
    - 1. Refrigerators
    - 2. Reducing agent
    - 3. Preserving of foods
    - 4. Preparation of sulfuric acid
- II. Sulfuric acid
  - A. Preparation of
    - 1. Contact process

- 2. Chamber process
- B. Properties of
  - 1. Physical
  - 2. Chemical
    - a. Dilute
    - b. Concentrated
    - c. Sulfate ion
    - d. Action on metals
- C. Uses of
  - 1. Dehydrating agent
  - 2. Preparation of other acids
  - 3. Plating of metals

#### Activities No. II

##### Oxides and Acids of Sulfur

- A. Demonstration of the action of dilute sulfuric acid upon zinc
- B. Demonstration of the action of concentrated sulfuric acid upon zinc
- C. Demonstration of action of hot sulfuric acid with metals
- D. Demonstration of dehydrating action of sulfuric acid.

#### Correlations No. II

##### Oxides and Acids of Sulfur

- A. Reading - Specific references
- B. Mathematics - Chemical problems
- C. Spelling - New terms such as pyrites, sulfites, bisulfites, platinum, sulfates

#### Work Sheet No. II

##### Oxides and Acids of Sulfur

Complete the following statements.

1. In the preparation of dilute sulfuric acid the \_\_\_\_\_ should always be poured into the \_\_\_\_\_.
2. To prepare a 1 to 6 mixture of sulfuric acid in water, 1 part of \_\_\_\_\_ is used to every 6 parts of \_\_\_\_\_.
3. Gases are often bubbled through concentrated sulfuric acid to \_\_\_\_\_ them.
4. Many metallic oxides can be removed from metals by the process of "pickling" the oxidized metals in sulfuric acid because the oxides react with \_\_\_\_\_ yielding soluble \_\_\_\_\_.
5. Hot concentrated sulfuric acid acts as an \_\_\_\_\_ agent.
6. \_\_\_\_\_ is liberated when most metals react with dilute acids.
7. Gases which \_\_\_\_\_ with sulfuric acid cannot be dried in this fashion.
8. Sulfur dioxide is prepared in the laboratory by the action of \_\_\_\_\_ acid upon a \_\_\_\_\_.
9. Sulfur dioxide reacts with bases to produce a \_\_\_\_\_.
10. Sulfur dioxide aids in retaining the \_\_\_\_\_ in drying fruits.
11. \_\_\_\_\_ is used as a catalyst in preparing  $\text{SO}_3$ .
12.  $\text{SO}_3$  reacts with water forming \_\_\_\_\_.
13. The \_\_\_\_\_ process of preparing sulfuric acid yields a moderately strong acid.
14. Epsom salts is chemically named \_\_\_\_\_.
15. Copper sulfate is commonly called \_\_\_\_\_.

Mark the following statements true or false, using the plus (+) sign for true and the zero (0) sign for false.

- \_\_\_\_\_ 1. Sulfur dioxide is soluble in water.
- \_\_\_\_\_ 2. Sulfur dioxide is a odorless gas.
- \_\_\_\_\_ 3. Sulfur dioxide reacts with water to form sulfuric acid.
- \_\_\_\_\_ 4. Sulfur dioxide is easily compressed.
- \_\_\_\_\_ 5. Sulfur dioxide is an oxidizing agent.
- \_\_\_\_\_ 6. Sulfur dioxide may be used as a bleaching agent.
- \_\_\_\_\_ 7. Sulfuric acid is an oily liquid.
- \_\_\_\_\_ 8. Concentrated sulfuric acid acts on metal more slowly than dilute.
- \_\_\_\_\_ 9. Barium sulfate is insoluble in water.
- \_\_\_\_\_ 10. Hot concentrated sulfuric acid reacts with zinc to produce hydrogen.

Key to Work Sheet No. II

Oxides and Acids of Sulfur

Completion

- 1. Acid, water
- 2. Acid, water
- 3. Dry
- 4. Acid, sulfates
- 5. Oxidizing
- 6. Hydrogen
- 7. Combine
- 8. Sulfuric, sulfite
- 9. Sulfite
- 10. Color
- 11. Platinum
- 12. Sulfuric acid
- 13. Contact
- 14. Magnesium sulfate
- 15. Blue stone

True and false

- |      |      |       |
|------|------|-------|
| 1. + | 5. 0 | 9. +  |
| 2. 0 | 6. + | 10. 0 |
| 3. 0 | 7. + |       |
| 4. + | 8. + |       |

### Study Guide No. III

#### The Chemistry of Glass

- A. Description of the manufacture of glass
- B. List of chemicals used in glass
- C. Description of preparation of window glass
- D. Contrast of plate glass and ordinary glass
- E. List of some common varieties of glass
- F. Description of special characteristics of each
- G. Description of coloring of glass
- H. Definition of ceramics
- I. List of some common ceramics
- J. Description of preparation and characteristics of each ceramics
- K. Description of preparation of Portland cement

#### References

- Rawlins - Struble, Chemistry in Action, pp. 428-441.
- Biddle - Bush, Chemistry Today, pp. 353-363.
- Foster, The Romance of Chemistry, pp. 308-323.
- Holmes, Out of the Test Tube, pp. 298-304.

### Subject Matter No. III

#### The Chemistry of Glass

#### I. Glass

##### A. Manufacture of

1. Composition of
2. Raw materials used
3. Chemical reactions
4. Window panes
5. Plate glass

B. Varieties of glass

1. Foam glass
2. Tempered glass
3. Optical glass
4. Pyrex glass
5. Safety glass
6. Water glass
7. Quartz glass

C. Coloring of

II. Ceramics

A. Definition of

B. Clay

1. Composition of
2. Preparation into
  - a. Earthenware
  - b. Common brick
  - c. Drainage tile

C. Porcelain - chinaware

1. Materials used
2. Molding
3. Glazing
4. Coloring

## III. Cement

- A. Materials used
- B. Manufacture of

## IV. Borax

- A. Sources
- B. Uses

## Activities No. III

## The Chemistry of Glass

- A. Showing of the film "Sand and Flame" obtained from the U.S. Department of Interior, Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh 13, Pennsylvania
- B. Showing of the film "From Mountain to Cement Sack" obtained from the U.S. Department of Interior, Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh 13, Pennsylvania

## Correlations No. III

## The Chemistry of Glass

- A. Reading - Specific references
- B. Physics - Light and color
- C. Biology - Diseases prevalent in glass industry
- D. Spelling - New terms such as silicate, silica, quartz, ceramics, porcelain

## Work Sheet No. III

## The Chemistry of Glass

Complete the following statements:

1. The raw materials used in making ordinary glass are a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_ d. \_\_\_\_\_.
2. The principle ingredient of all glass is \_\_\_\_\_.
3. \_\_\_\_\_ is mixed with ordinary glass in making foam glass.



4. Flint glass contains a large amount of \_\_\_\_\_.
5. Safety glass is made by putting a sheet of \_\_\_\_\_ between two layers of glass.
6. \_\_\_\_\_ glass is a syrupy solution of sodium silicate.
7. \_\_\_\_\_ glass will allow the passage of large amounts of ultraviolet light.
8. The addition of \_\_\_\_\_ to glass gives it a purple color.
9. \_\_\_\_\_ includes articles molded wholly or in part of clay, then baked.
10. \_\_\_\_\_ is a pure clay used in making chinaware.
11. Cement is a mixture of \_\_\_\_\_ and \_\_\_\_\_.
12. Concrete is made by adding \_\_\_\_\_ or \_\_\_\_\_ to cement.
13. Borax is a compound of \_\_\_\_\_.
14. Borax is used in making \_\_\_\_\_ and \_\_\_\_\_ glass.
15. \_\_\_\_\_ glass contains the highest per cent of silica.

Key to Work Sheet No. III

The Chemistry of Glass

1. Sand, washing soda, sodium sulfate, limestone
2. Silica
3. Carbon
4. Lead oxide
5. Vinyl acetate resin
6. Water
7. Quartz
8. Manganese
9. Ceramics
10. Kaolin

11. Clay and ~~silica~~
12. Sand or ~~silica~~
13. Boron
14. Crown and ~~silica~~
15. Pyrex

- ~~Section 1~~  
~~Section 2~~
- A. Experiment ~~Pyrex beaker~~
  - B. Experiment ~~ring glass~~
  - C. Experiment ~~qualitative~~ solutions of metal salts and hydroxide

~~Section 3~~  
~~Section 4~~

I. Knowledge ~~understand~~

A. Sulfur ~~its comp~~

1. ~~Sulfur~~

2. ~~Sulfur~~ in ~~Silica~~

3. ~~Sulfur~~ by ~~silica~~

~~Sulfur~~ chief ~~with~~

~~Sulfur~~ 99.5% ~~pure~~

~~Sulfur~~ not ~~in~~ quick sand deposits

~~Sulfur~~ melted ~~in~~ ~~the~~ ~~air~~ and air under pressure

~~Sulfur~~ allows

~~Sulfur~~ rhombic

(1) ~~Sulfur~~

(2) ~~Sulfur~~

## (2) Monoclinic

(a) Crystalline

(b) Unstable

## (3) Amorphous

(a) Produced by pouring boiling sulfur in water

(b) Non-crystalline

(c) Unstable

(d) Elastic

(e) Changes into rhombic

## d. Chemical properties

(1) Similar to oxygen

(2) Has six electrons in outer orbit

(3) Reacts with metals to produce sulfides

(4) Valence of -2

## e. Uses of

(1) Manufacture of sulfuric acid

(2) Fungicide

(3) Gunpowder, matches, dyes

(4) Ointments for skin diseases

## 2. Common sulfides

## a. Hydrogen sulfide

(1) Formed by decaying proteins

(2) Natural sulfur waters

(3) Action of hydrochloric acid upon iron sulfide

(4) Equation for above reaction



## (5) Physical properties

- (a) Colorless, poisonous, foul smelling
- (b) Moderately soluble in water
- (c) Heavier than air

## (6) Chemical properties

- (a) Burns to form sulfur dioxide in excess air
- (b) Equation for above reaction,  $2 \text{H}_2\text{S} + 3\text{O}_2 \longrightarrow 2 \text{H}_2\text{O} + 2 \text{SO}_2$
- (c) Burns in limited air to form sulfur and sulfur dioxide
- (d) Equation for above reaction,  

$$2 \text{H}_2\text{S} + 2 \text{O}_2 \longrightarrow 2 \text{H}_2\text{O} + \text{S} + \text{SO}_2$$
- (e) Burns in small amount of air to form sulfur and water
- (f) Equation for above reaction,  $2 \text{H}_2\text{S} + \text{O}_2 \longrightarrow 2 \text{H}_2\text{O} + 2 \text{S}$
- (g) Dissolves in water to form hydrosulfuric acid
- (h) A reducing agent

## b. Other sulfides

## (1) Metal ores

- (a) Galena,  $\text{PbS}$
- (b) Pyrites,  $\text{FeS}$
- (c) Cinnabar,  $\text{HgS}$

## (2) Carbon disulfide

## B. Oxides and acids of sulfur

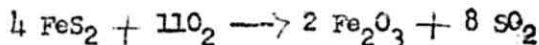
## 1. Sulfur dioxide

## a. Preparation

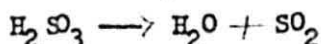
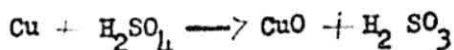
## (1) Burning of sulfur



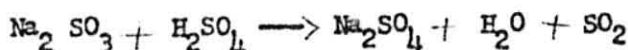
## (2) Roasting of sulfides



## (3) Reduction of sulfuric acid



(4) Action of acid on sulfite



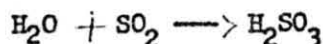
b. Properties of

(1) Physical

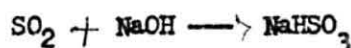
- (a) Colorless gas, pungent odor
- (b) Quiet soluble in water
- (c) Heavier than air
- (d) Easily liquified

(2) Chemical

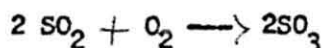
- (a) With water form sulfurous acid



- (b) With bases form sulfites or bisulfites



- (c) Oxidizes to form sulfur trioxide



c. Uses of

- (1) In refrigerators
- (2) Reducing agent - Bleaching
- (3) Drying of fruits - Color retainer

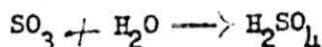
2. Sulfuric acid

a. Preparation of

(1) Contact process

- (a) Burning pyrites produces  $\text{SO}_2$
- (b)  $\text{SO}_2$  combines with  $\text{O}_2$  to produce  $\text{SO}_3$
- (c) Platinum used as catalyst

(d)  $\text{SO}_3$  plus water produces  $\text{H}_2\text{SO}_4$



(2) Chamber process

(a) Produces moderately strong acid

(b) Replaced by Contact process

b. Properties of

(1) Physical

(a) Colorless, odorless oily liquid

(b) Nearly twice as dense as water

(2) Chemical

(a) Dilute acid on metals produces hydrogen

(b) Turns blue litmus red

(c) Precipitates barium sulfate with barium salts



(d) Concentrated it is a dehydrating solution

(e) Hot concentrated acid is an oxidizing solution

c. Uses of

(1) Making of nitroglycerine

(2) Making other acids

(3) Plating of metals

(4) Making of storage batteries

C. Chemistry of glass

1. Glass

a. Composed mainly of

(1) Sand -  $\text{SiO}_2$

(2) Washing soda -  $\text{Na}_2\text{CO}_3$

(3) Sodium sulfite -  $\text{Na}_2\text{SO}_3$

(4) Limestone -  $\text{CaCO}_3$

- b. A supercooled liquid
- c. Non-crystalline in structure
- d. Rolled in two thin sheets
- e. Annealed to prevent internal strain
- f. Plate glass

- (1) Chemicals same as ordinary glass
- (2) Better selected chemicals
- (3) Polished for smooth surface

g. Varieties of glass

- (1) Foam glass - Contains carbon
- (2) Tempered glass
  - (a) Heated above annealing temperature
  - (b) Suddenly cooled
  - (c) Strengthens glass
- (3) Optical glass
  - (a) Flint glass
  - (b) Contain lead oxide
  - (c) Crown glass
- (4) Pyrex glass
- (5) Safety glass - Vinyl acetate film between glass plates
- (6) Water glass - Sodium silicate dissolved in water
- (7) Quartz glass
  - (a) Pure sand melted
  - (b) Passes most ultraviolet rays

h. Color - By adding various metals or compounds

## 2. Ceramics

a. Definition - Includes articles made of wholly or part clay,  
molded and baked

b. Earthenware - Clay molded and baked

c. Chinaware - Pure clay is used

3. Cement

a. Contains clay and limestone

b. Mixed with sand to form concrete

II. Attitude toward:

- A. Concrete and its usefulness to man
- B. Cement and its usefulness to man
- C. Sulfur and its importance
- D. Sulfuric acid and its commercial uses
- E. Life more enjoyable through chemistry
- F. Good study habits
- G. Improvements of glass through chemistry
- H. Glass for varying uses
- I. Advantages of study guides
- J. Labor story as an aid in studying

III. Habit of:

- A. Using past knowledge of chemistry
- B. Associating chemistry with everyday things
- C. Studying regularly
- D. Understanding practical uses of chemistry
- E. Reading current scientific articles
- F. Doing all work completely
- G. Appreciating the improvement in commercial products
- H. Using study aids
- I. Thinking clearly



IV. Appreciation for:

- A. Many forms of glass
- B. Contributions of chemistry to glass industry
- C. Improvements in glass
- D. Uses of sulfur in commercial processes
- E. Uses of concrete
- F. Uses of cement
- G. Beautiful but economical chinaware
- H. Beautiful glassware
- I. Safety glass
- J. Study aids
- K. Laboratory experiments
- L. Films on topics of study
- M. An understanding of chemistry

Leads to Other Units

Some Important Non-Metals

The student will now enter the final unit of his study in chemistry. He should use all of his past gained knowledge in chemistry to help him understand the last unit.

IV. The Metals

Teacher Evaluation  
Some Important Non-Metals

To what extent does the unit:	Ex.	V.G.	G.	F.	P.	None
1. Involve a variety of direct sensory experiences?	✓					
2. Provide for free informal associations of pupils?	✓					
3. Provide an opportunity for manipulative activity?	✓					
4. Make a coherent whole?		✓				
5. Provide a considerable amount of student activity?	✓					
6. Produce satisfying outcomes?			✓			
7. Provide sufficient concrete and illustrative material?		✓				
8. Have a useful purpose in the present and future life of the pupils?			✓			
9. Reproduce actual life situations as far as possible?			✓			
10. Utilize materials as they occur in life?			✓			
11. Contain some accurate material?		✓				
12. Provide opportunity for pupils to originate, plan and direct activity as far as possible?			✓			

13. Provide opportunity to judge, choose, and evaluate?
14. End lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete exact references?

Ex.	V.G.	G.	F.	P.	None
	✓				
	✓				
	✓				
✓					
✓					

#### Pupil Test

#### Knowledge Test

#### Some Important Non-Metals

Complete the following statements:

- Prior to 1904 most of the sulfur came from \_\_\_\_\_.
- Most of our supply now comes from the two states \_\_\_\_\_ and \_\_\_\_\_.
- Sulfur is mined in these two states by the \_\_\_\_\_ process.
- Three allotropic forms of sulfur are a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_.
- \_\_\_\_\_ is the stable form of sulfur.
- \_\_\_\_\_ is the non-crystalline form of sulfur.
- Sulfur reacts with metals to produce metal \_\_\_\_\_.
- Sulfur is chemically similar to the element \_\_\_\_\_.
- The common valence of sulfur is \_\_\_\_\_.
- Silver tarnishing is due to the formation of \_\_\_\_\_.

11. Sulfur is used in the \_\_\_\_\_ of rubber.
12. Hydrogen sulfide is prepared in the laboratory by the action of \_\_\_\_\_ and upon \_\_\_\_\_.
13. Carbon disulfide is used as a \_\_\_\_\_.
14. Sulfur dioxide can be made by roasting \_\_\_\_\_ ores.
15. The reduction of \_\_\_\_\_ acid by copper will produce sulfur dioxide.
16. Sulfur dioxide may be prepared in the laboratory by the action of an acid upon a \_\_\_\_\_.
17. \_\_\_\_\_ acid is a water solution of sulfur dioxide.
18. Sulfur dioxide reacts with bases to form a \_\_\_\_\_ or \_\_\_\_\_.
19. Sulfur dioxide is a \_\_\_\_\_ agent.
20. \_\_\_\_\_ is used to retain the color of dried fruits.
21. Sulfuric acid is made by the two processes known as a. \_\_\_\_\_  
b. \_\_\_\_\_.
22. Sulfur dioxide oxidizes into \_\_\_\_\_.
23. Sulfuric acid may be made by passing \_\_\_\_\_ into water.
24. Fuming sulfuric acid is made by passing \_\_\_\_\_ into weak acid.
25. Dilute sulfuric acid reacts with most metals to form \_\_\_\_\_.
26. Dilute sulfuric acid ionizes into \_\_\_\_\_ and ions \_\_\_\_\_.
27. Concentrated sulfuric acid ionizes into \_\_\_\_\_ and \_\_\_\_\_ ions.
28. Concentrated sulfuric acid is a good \_\_\_\_\_ agent.
29. Hot concentrated sulfuric acid is a good \_\_\_\_\_ agent.

30. The removal of oxides from metals by sulfuric acid is called \_\_\_\_\_.
31. Glass is a solution composed mainly of a. \_\_\_\_\_  
b. \_\_\_\_\_ c. \_\_\_\_\_ d. \_\_\_\_\_.
32. The principal ingredient of all glass is \_\_\_\_\_.
33. Flint glass contains a large amount of \_\_\_\_\_.
34. \_\_\_\_\_ glass has various gases mixed in it.
35. \_\_\_\_\_ glass has the highest percentage of sand along with other minerals
36. \_\_\_\_\_ glass is pure melted sand.
37. \_\_\_\_\_ glass allows the passage of nearly all ultraviolet light rays.
38. Kaolin is used in making \_\_\_\_\_ or \_\_\_\_\_.
39. \_\_\_\_\_ is used in making all earthenware, bricks, tile.
40. Cement is made from a mixture of \_\_\_\_\_ and \_\_\_\_\_.
41. Complete the following equations:
- $4\text{Al} + 3\text{O}_2 \longrightarrow$
  - $\text{Mg} + \text{S} \longrightarrow$
  - $\text{HCl} + \text{FeS} \longrightarrow$
  - $2\text{H}_2\text{S} + 3\text{O}_2 \longrightarrow$
  - $\text{Ag} + \text{S} \longrightarrow$
  - $\text{SO}_2 + \text{O}_2 \longrightarrow$
  - $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow$
  - $\text{SO}_2 + \text{H}_2\text{O} \longrightarrow$
  - $\text{Zn} + \text{H}_2\text{SO}_4 \xrightarrow{\text{dilute}}$
  - $\text{AgNO}_3 + \text{H}_2\text{S} \longrightarrow$

## Key to Knowledge Test

## Some Important Non-Metals

- |   |                                 |
|---|---------------------------------|
| 1. Sicily   | 16. Sulfite                     |
| 2. Louisiana and Texas                            | 17. Sulfurous                   |
| 3. Frasch   | 18. Sulfite or bisulfite        |
| 4. Rhombic, monoclinic, amorphous                 | 19. Reducing                    |
| 5. Rhombic  | 20. Sulfur dioxide              |
| 6. Amorphous                                      | 21. Contact or chamber          |
| 7. Sulfides                                       | 22. Sulfur trioxide             |
| 8. Oxygen   | 23. Sulfur trioxide             |
| 9. -2   | 24. Sulfur trioxide             |
| 10. Silver sulfide                                | 25. Hydrogen                    |
| 11. Vulcanizing                                   | 26. $2H^+$ and $SO_4^{--}$ —>   |
| 12. Sulfuric, sulfite                             | 27. $H^+$ and $HSO_4^{--}$ ---> |
| 13. Solvent                                       | 28. Dehydrating                 |
| 14. Sulfide                                       | 29. Oxidizing                   |
| 15. Sulfuric                                      | 30. Pickling                    |
| 31. Sand, washing soda, sodium sulfite, limestone |                                 |
| 32. Sand  |                                 |
| 33. Lead oxide                                    |                                 |
| 34. Foam  |                                 |
| 35. Pyrex   |                                 |
| 36. Quartz  |                                 |
| 37. Quartz  |                                 |
| 38. Porcelain, chinaware                          |                                 |
| 39. Clay  |                                 |
| 40. Clay and limestone                            |                                 |

11. (a)  $4\text{Al} + 3\text{O}_2 \longrightarrow 2\text{Al}_2\text{O}_3$   
 (b)  $\text{Mg} + \text{S} \longrightarrow \text{MgS}$   
 (c)  $2\text{HCl} + \text{FeS} \longrightarrow \text{H}_2\text{S} + \text{FeCl}_2$   
 (d)  $2\text{H}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + 2\text{SO}_2$   
 (e)  $\text{Ag} + \text{S} \longrightarrow \text{Ag}_2\text{S}$   
 (f)  $\text{SO}_2 + 2\text{O}_2 \longrightarrow 2\text{SO}_3$   
 (g)  $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$   
 (h)  $\text{SO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_3$   
 (i)  $\text{Zn} + \text{H}_2\text{SO}_4 \longrightarrow \text{ZnSO}_4 + \text{H}_2$   
 (j)  $2\text{AgNO}_3 + \text{H}_2\text{S} \longrightarrow 2\text{HNO}_3 + \text{Ag}_2\text{S}$

#### Pupil Test

#### Attitude Test

#### Some Important Non-Metals

Answer yes or no.

- \_\_\_\_\_ 1. Do you feel that a study of chemistry is helping you?
- \_\_\_\_\_ 2. Do you appreciate glass more now that you have studied its composition?
- \_\_\_\_\_ 3. A study of sulfuric acid is a waste of time.
- \_\_\_\_\_ 4. Chemistry is constantly improving our commercial products.
- \_\_\_\_\_ 5. Glass has been improved through chemistry.
- \_\_\_\_\_ 6. I like to study chemistry more each day.
- \_\_\_\_\_ 7. Study guides are of little help to me.
- \_\_\_\_\_ 8. Laboratory experiment does not help me to understand chemistry.
- \_\_\_\_\_ 9. Clean equipment helps to obtain more accurate results in the laboratory.
- \_\_\_\_\_ 10. I have learned to do more accurate work.

## Pupil Test

## Habit Test

## Some Important Non-Metals

Answer yes or no.

- \_\_\_\_\_ 1. I always leave my equipment clean.
- \_\_\_\_\_ 2. I use my study aids.
- \_\_\_\_\_ 3. I read the labels on all reagent bottles before I use the chemicals.
- \_\_\_\_\_ 4. I read current scientific articles.
- \_\_\_\_\_ 5. I study regularly.
- \_\_\_\_\_ 6. I perform all laboratory experiments completely.
- \_\_\_\_\_ 7. I associate chemistry with a piece of glass when I see one.
- \_\_\_\_\_ 8. I associate my knowledge of sulfuric acid with the car battery.
- \_\_\_\_\_ 9. I see chemistry in a piece of concrete.
- \_\_\_\_\_ 10. I associate chemistry with decaying matter.

## Key to Habit Test

## Some Important Non-Metals

A desirable answer would be yes to all statements.

## Pupil Test

## Appreciation Test

## Some Important Non-Metals

Answer the following statements with a yes or no.

- \_\_\_\_\_ 1. I appreciate glass more now that I have studied its composition.
- \_\_\_\_\_ 2. I appreciate the films shown on the topics of study.
- \_\_\_\_\_ 3. I appreciate understanding of the nature of various chemicals.
- \_\_\_\_\_ 4. I appreciate accurate work.
- \_\_\_\_\_ 5. I appreciate laboratory work.



- \_\_\_\_\_ 6. I appreciate my knowledge of chemistry.
- \_\_\_\_\_ 7. I appreciate personal accomplishments.
- \_\_\_\_\_ 8. I appreciate sulfuric acid and its characteristics.
- \_\_\_\_\_ 9. I appreciate chemistry and its contributions to man's progress.
- \_\_\_\_\_ 10. I appreciate current scientific articles.

#### Key to Appreciation Test

#### Some Important Non-Metals

A desirable answer would be yes to all statements.

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#### Some Important Non-Metals

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#### Pupil

Rawlins - Struble, Chemistry in Action, (D. C. Heath and Co., Chicago, Ill., 1948).

Foster, William, Romance of Chemistry, (Rand McNally and Company, Chicago, Ill., 1936).

Jaffe, Barnard, The New World of Chemistry, (Silver Burdett Company, Chicago, Ill., 1949).

Biddle - Bush, Chemistry Today, (Rand McNally and Company, Chicago, Ill., 1949).

Holmes, Harry N., Out of the Test Tube, (Emerson Books, Inc., New York, 1943).

## Unit No. IX

## The Metals

The mineral resources of a nation are of extreme importance. The United States is fortunate in having rich mineral deposits, but World War II demonstrated that even our mineral wealth must be conserved. The metals are in general secured from minerals or ores. Practically all of the metals may be considered essential in modern life because so many varied uses have been found for them.

Methods for separating and utilizing the metals and their compounds have been generally improved through the years. Since ore reserves are expendible it is desirable to develop further methods for their utilization. You will find much that is interesting in a study of the problems in this unit.

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## IX. Development or Procedure

## A. Iron

1. Study Guide No. I
2. Subject Matter No. I
3. Activities No. I
4. Correlations No. I
5. Work Sheet No. I
6. Key to Work Sheet No. I

## B. The Active Metals

1. Study Guide No. II
2. Subject Matter No. II
3. Activities No. II
4. Correlations No. II
5. Work Sheet No. II
6. Key to Work Sheet No. II

## C. The "Heavy" Metals

1. Study Guide No. III
2. Subject Matter No. III
3. Activities No. III
4. Correlations No. III
5. Work Sheet No. III
6. Key to Work Sheet No. III

## X. Culminating Activities

## XI. Desirable Outcomes

- A. Knowledge and Understanding of
- B. Attitude toward
- C. Habit of

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### Criteria for Evaluation of a Unit<sup>20</sup>

#### The Metals

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal, association of the pupils.
3. It should provide an opportunity for manipulative or bodily activity.
4. The parts of the unit should make a coherent whole.
5. It should provide for a considerable amount of pupil activity.
6. It should be satisfying or the anticipation of the outcomes should be satisfying.
7. It should provide sufficient concrete and illustrative material.
8. The unit of work should have a useful purpose in the present or future life of the pupil,
9. It should reproduce actual life situations.

<sup>20</sup>

Harap, Western Reserve Bulletin, No. 17, November 30, 1931, p. 6.

10. It should utilize materials as they occur in life.
11. It should contain accurate information.
12. It should provide for opportunity for the pupils to originate, plan, and direct the activity as far as possible.
13. It should provide opportunity to judge, choose, and evaluate.
14. It should be within the available time for the unit.
15. The exposition should be clear enough to make it possible for a new teacher to put the unit into practice if she desires.
16. It should state clearly where materials may be found.
17. Where references are given, they should be complete and exact.

Grade Placement - Grade Eleven or Twelve

Time Allotment - Twenty-five Days

Central Theme - The Sinews of Industry

#### Objectives

#### The Metals

#### A. Knowledge and Understanding of:

1. Iron and its characteristics
2. The active metals, sodium, potassium, and calcium
3. The "heavy" metals, copper, lead, silver

#### B. Attitude toward:

1. Importance of metals to industry
2. Conservation of metals
3. Metals usefulness in everyday living
4. Construction of storage cell
5. Benefits derived from studying chemistry
6. Manufacture of paint

C. Habit of:

1. Conserving metals
2. Using good study habits
3. Associating chemistry with things you use
4. Reading scientific articles
5. Applying your knowledge of chemistry

D. Appreciation for:

1. New uses of metals
2. Understanding of paint manufacture
3. Understanding of the storage cell
4. Chemistry's contributions to pleasant living
5. Natural characteristics of minerals
6. A study of chemistry
7. Laboratory experimentation
8. Good work

Approaches

The Metals

The unit may be effectively introduced by:

1. Demonstrating action of sodium on water
2. Constructing a simple lead storage cell
3. Electroplating with silver
4. Showing the film "Steel Alloy" obtained from the U. S. Department of Interior, Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh 13, Pennsylvania

Study Guide No. I

Iron

- A. List of physical properties of metal

- B. List of chemical properties of metals
- C. List of the metallurgical processes
- D. Discussion of operation of the blast furnace
- E. Discussion of operation of the Bessemer Converter
- F. Description of production of steel
- G. Definition of annealing, case hardening, nitriding, tempering
- H. Discussion of the rusting of iron
- I. List of some common iron compounds and their uses

#### References

- Rawlins - Struble, Chemistry in Action, pp. 446-469.
- Price - Bruce, Chemistry and Human Affairs, pp. 434-480.
- Carleton - Carpenter, Chemistry for the New Age, pp. 488-453.

#### Subject Matter No. I

##### Iron

- I. Characteristics of metals
  - A. Physical properties
  - B. Chemical properties
  - C. Minerals and ores
    - 1. Definition of
    - 2. Metallurgy
- II. Iron
  - A. Sources of
  - B. Blast furnace operation
    - 1. Chemical used
    - 2. Chemical reactions involved
    - 3. Product - Pig iron
  - C. Removal of impurities

D. Steel

1. Operation of Bessemer Converter
  - a. Chemicals used
  - b. Product
2. Open-hearth process
  - a. Chemicals used
  - b. Product
3. Hi-grade steel
4. Treatments of
  - a. Annealing
  - b. Case hardening
  - c. Nitriding
  - d. Tempering

E. Alloys

1. Nature of
2. Classes

F. Rusting of

1. Cause
2. Prevention

G. Complex salts

H. Iron compounds

I. Test for

1. Ferrous ion
2. Ferric ion

J. Blue prints



## Activities No. I

## Iron

- A. Experiment - Reduction of copper oxide with carbon
- B. Experiment - Testing for ferrous and ferric ions
- C. Experiment - Oxidation and reduction of ferrous and ferric ions

## Correlations No. I

## Iron

- A. Reading - Specific references
- B. Writing - Laboratory experiments
- C. Mechanical Drawing - Blue prints
- D. Printing - Laks

## Work Sheet No. I

## Iron

Mark the following statements true or false using the plus (+) sign for true and zero (0) for false.

- \_\_\_\_\_ 1. Metals form only bases when in solution.
- \_\_\_\_\_ 2. All metals are solids.
- \_\_\_\_\_ 3. Metals are crystalline in the solid state.
- \_\_\_\_\_ 4. Lithium is our lightest known metal.
- \_\_\_\_\_ 5. All metals are good conductors of electricity when at a low temperature.
- \_\_\_\_\_ 6. Silver will conduct electricity better than copper.
- \_\_\_\_\_ 7. All metals lose electrons and become positive ions in solution.
- \_\_\_\_\_ 8. All metals exist in the free state to some extent.
- \_\_\_\_\_ 9. Carbon dioxide is used to reduce iron oxide in the blast furnace.
- \_\_\_\_\_ 10. Calcium carbonate is used as a flux in the blast furnace.
- \_\_\_\_\_ 11. Pig iron is pure iron.

- \_\_\_\_ 12. Most of the supply of steel is made in the Bessemer Converter process.
- \_\_\_\_ 13. Manganese is added to iron to make it hard.
- \_\_\_\_ 14. Steel made in Bessemer process is our highest type of steel.
- \_\_\_\_ 15. Steel made by the open hearth process is superior to that of the Bessemer process.
- \_\_\_\_ 16. Tool steel is made by the electric furnace process.
- \_\_\_\_ 17. Wrought iron contains more carbon than pig iron.
- \_\_\_\_ 18. Steel is hardened by the process of annealing.
- \_\_\_\_ 19. Car wheels are made of case hardened steel.
- \_\_\_\_ 20. Nitrided steel is made by heating steel in the presence of pure nitrogen.
- \_\_\_\_ 21. Steel is an alloy.
- \_\_\_\_ 22. All alloys are mixtures of two or more metals.
- \_\_\_\_ 23. A layer of rust on iron helps to speed up the process of oxidation.
- \_\_\_\_ 24. The ferrous ion has a valence of -3.
- \_\_\_\_ 25. Iron usually has a valence of -2 or -3.

Complete the following statements:

1. Steel is an alloy of \_\_\_\_\_ and \_\_\_\_\_.
2. Steel is made by adding \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_ to iron.
3. \_\_\_\_\_ is the process of heating steel and suddenly cooling it.
4. \_\_\_\_\_ is used with oxygen to make carbon dioxide in the blast furnace.
5. The carbon dioxide is reduced to \_\_\_\_\_.
6. Fool's gold is \_\_\_\_\_.

## Key to Work Sheet No. I

## Iron

## True or false

1. 0	6. +	11. 0	16. +	21. +
2. 0	7. +	12. 0	17. 0	22. 0
3. +	8. 0	13. +	18. 0	23. +
4. +	9. +	14. 0	19. +	24. 0
5. +	10. +	15. +	20. 0	25. +

## Completion

1. Iron and carbon
2. Carbon, silicon, manganese
3. Tempering
4. Coke
5. Carbon monoxide
6. Iron pyrite

## Study Guide No. II

## The Active Metals

- A. Definition of alkali
- B. Description of commercial preparation of sodium
- C. List of some common sodium compounds and their uses
- D. Discussion of the use of the spectroscope
- E. Discussion of the use of the potassium compounds
- F. Description of the formation of stalactites and stalagmites
- G. Discussion of the characteristics of hard water
- H. Discussion of the ways of softening water
- I. Distinguishing between quick lime and slacked lime
- J. Discussion of the use of mortar, stucco, Plaster of Paris

## References

- Rawlins - Struble, Chemistry in Action, pp. 483-499.  
Biddle - Bush, Chemistry Today, pp. 329-352.  
Jaffe, New World of Chemistry, pp. 485-517.

## Subject Matter No. II

## The Active Metals

## I. Sodium

## A. Commercial preparation

## B. Compounds of sodium

## 1. Sodium chloride

## a. Source

## b. Uses

## 2. Sodium carbonates

## a. Sodium carbonate

## (1) Common names

## (2) Uses

## b. Sodium bicarbonate

## 3. Sodium hydroxide

## a. Uses

## b. Preparation

## C. Test for

## D. The spectroscope

## 1. Operation

## 2. Uses

## II. Potassium

## A. Characteristics

## B. Test for

### III. Calcium

#### A. Sources

#### B. Calcium carbonate

1. Sources
2. Cave formation
3. Stalactites
4. Stalagmites
5. Hard water
  - a. Temporary
  - b. Permanent
  - c. Methods of softening
    - (1) Heating
    - (2) Use of chemicals
    - (3) Zeolite
    - (4) Distillation
    - (5) Detergents

#### C. Lime

1. Calcium oxide
  - a. Preparation
  - b. Chemical properties
2. Calcium hydroxide
  - a. Preparation
  - b. Uses
3. Mortar
4. Plaster
5. Stucco

#### D. Calcium sulfate

## 1. Sources

## 2. Plaster of Paris

## Activities No. II

## The Active Metals

- A. Experiment - Preparation and softening of temporary hard water
- B. Experiment - Preparation and softening of permanent hard water

## Correlations No. II

## The Active Metals

- A. Reading - Specific references
- B. Writing - Experiments
- C. Spelling - New terms such as stalagmite, stalactite, spectroscope, zeolite, detergent
- D. Geology - Cave formations
- E. Physics - Use of spectroscope

## Work Sheet No. II

## The Active Metals

Mark the following statements true or false using the plus (+) for true and the zero (0) for false.

- \_\_\_\_\_ 1. All hydroxides are commonly called alkalies.
- \_\_\_\_\_ 2. Sodium is stored under water to keep it from oxidizing.
- \_\_\_\_\_ 3. Sal soda is chemically known as sodium carbonate.
- \_\_\_\_\_ 4. Baking soda is composed of sodium bicarbonate.
- \_\_\_\_\_ 5. Sodium hydroxide is prepared by the electrolysis of brine.
- \_\_\_\_\_ 6. Sodium turns a flame to a red color.
- \_\_\_\_\_ 7. Potassium is very similar to sodium in its properties.
- \_\_\_\_\_ 8. Potassium gives a flame a violet color.
- \_\_\_\_\_ 9. Bones contain calcium phosphate.

- \_\_\_\_ 10. Chalk is mainly calcium phosphate.  
 \_\_\_\_ 11. Marble was at one time limestone.  
 \_\_\_\_ 12. Caves occur in regions containing large deposits of calcium carbonate.  
 \_\_\_\_ 13. Stalactites are deposits of calcium bicarbonate.  
 \_\_\_\_ 14. Stalactites in caves form from the ground up.  
 \_\_\_\_ 15. Temporary hard water contains calcium bicarbonate salts.  
 \_\_\_\_ 16. Temporary hard water can be made soft simply by boiling.  
 \_\_\_\_ 17. Permanent hard water can be made soft by distillation.  
 \_\_\_\_ 18. Permanent hard water contains sulfate salts of calcium and magnesium.  
 \_\_\_\_ 19. Hard water may be made soft by use of various chemicals.  
 \_\_\_\_ 20. All detergents form insoluble soaps in hard water.  
 \_\_\_\_ 21. Quicklime is chemically known as calcium hydroxide.  
 \_\_\_\_ 22. Good mortar improves with age.  
 \_\_\_\_ 23. Plaster of Paris is known as calcium sulfate.  
 \_\_\_\_ 24. Stucco contains some cement.  
 \_\_\_\_ 25. Calcium hydroxide is commonly called lime.

#### Key to Work Sheet No. II

##### The Active Metals

1. 0	6. 0	11. +	16. +	21. 0
2. 0	7. +	12. +	17. +	22. +
3. +	8. +	13. 0	18. +	23. +
4. +	9. +	14. 0	19. +	24. 0
5. +	10. 0	15. +	20. 0	25. +

## Study Guide No. III

## The "Heavy" Metals

- A. List of the chemical and physical properties of copper
- B. Discussion of method of refining copper
- C. List of uses made of copper
- D. Discussion of purification of lead ore into lead
- E. Diagraming and discussing chemical reactions in lead storage cell
- F. Description of different chemical reactions when charging and discharging storage cell
- G. Discussion of manufacture of paint
- H. List of properties of silver
- I. List of uses of silver and describe each
- J. Discussion of the use of silver salts in photography
- K. List of properties of mercury
- L. Description of uses of mercury
- M. List of properties of gold and platinum

## References

- Rawlins - Struble, Chemistry in Action, pp. 509-526.
- Ahrens - Bush - Easley, Living Chemistry, pp. 491-506, 280-290.
- Jaffe, The New World of Chemistry, pp. 444-483.
- Biddle - Bush, Chemistry Today, pp. 439-512.

## Subject Matter No. III

## The "Heavy" Metals

- I. Copper
  - A. Properties
    - 1. Physical
    - 2. Chemical



- B. Ore refining
  - 1. Compound
  - 2. Basic process
  - 3. Chemical reactions
- C. Test for
- D. Lead storage cell
  - 1. Structure of
  - 2. Chemical reactions
    - a. Charging
    - b. Discharging
- E. Paint
  - 1. Composition
  - 2. Old Dutch Process

### III. Silver

- A. Properties of
  - 1. Physical
  - 2. Chemical
- B. Uses of
  - 1. Electroplating
  - 2. Mirrors
  - 3. Photography
    - a. Film
    - b. Exposure
    - c. Developing
    - d. Fixing
    - e. Printing

#### IV. Mercury

##### A. Properties

1. Chemical
2. Physical

##### B. Uses of

##### C. Compounds of

1. Oxides
2. Chloride

#### V. Gold

##### A. Properties

1. Chemical
2. Physical

##### B. Uses of

##### C. Prospecting

#### VI. Platinum

##### A. Properties of

1. Chemical
2. Physical

##### B. Uses of

#### Activities No. III

#### The "Heavy" Metals

- A. Experiment - Silvering of glass
- B. Experiment - Effect of light on a silver halide
- C. Experiment - The action of a developer
- D. Experiment - The action of a hypo
- E. Experiment - The chloride test for silver, lead, and mercurous mercury

## Correlations No. III

## The "Heavy" Metals

- A. Reading - Specific references
- B. Writing - Experiments
- C. Physics - Lead storage cell and electricity
- D. Geology - Metal ores of lead, copper, silver

## Work Sheet No. III

## The "Heavy" Metals

Mark the following statements true or false using the (+) plus for true and the zero (0) for false.

- \_\_\_\_\_ 1. Dilute hydrochloric acid will not act upon copper.
- \_\_\_\_\_ 2. Copper does not oxidize in the air.
- \_\_\_\_\_ 3. Copper does not exist in the free state in the earth's surface.
- \_\_\_\_\_ 4. Small traces of impurities in copper decreases its conductivity.
- \_\_\_\_\_ 5. Green wood poles are used to remove sulfur from copper.
- \_\_\_\_\_ 6. Pure copper is obtained by electroplating.
- \_\_\_\_\_ 7. Copper always has a valence of -2.
- \_\_\_\_\_ 8. All soluble copper salts are poisonous.
- \_\_\_\_\_ 9. Copper can be replaced in solution by the use of metals above hydrogen in the electromotive series.
- \_\_\_\_\_ 10. Color of the flame in the copper test is that of green.
- \_\_\_\_\_ 11. Nitric acid will not react with lead.
- \_\_\_\_\_ 12. Soluble lead salts are poisonous.
- \_\_\_\_\_ 13. "Painter's colic" is due to the accumulation of copper in the body.
- \_\_\_\_\_ 14. In the storage cell both the plates are made of lead.
- \_\_\_\_\_ 15. The closer the plates are together in a cell the less the internal resistance.

- \_\_\_\_\_ 16. The more plates there are in a cell the more current it will produce.
- \_\_\_\_\_ 17. The negative plates of a cell are made of lead oxide.
- \_\_\_\_\_ 18. During discharge of the storage cell both plates are converted to lead sulfate.
- \_\_\_\_\_ 19. During discharge of a storage cell the electrolyte becomes less dense.
- \_\_\_\_\_ 20. The most commonly used pigment in paint is lead carbonate.
- \_\_\_\_\_ 21. Silver will not combine with oxygen at ordinary temperatures.
- \_\_\_\_\_ 22. The tarnish on silver ware is due to the presence of silver oxide.
- \_\_\_\_\_ 23. Silver can best be cleaned by the electrolytic process.
- \_\_\_\_\_ 24. Photographic films contain silver salts.
- \_\_\_\_\_ 25. In film exposure the silver salts are changed by the light.
- \_\_\_\_\_ 26. The film developer changes the silver salts to free silver.
- \_\_\_\_\_ 27. Mercury displaces hydrogen from the acids.
- \_\_\_\_\_ 28. Mercury is a poor conductor of electricity.
- \_\_\_\_\_ 29. Gold will dissolve in mercury.
- \_\_\_\_\_ 30. Platinum will not oxidize.

Complete the following statements:

1. The protective coating on copper metal exposed to the air is \_\_\_\_\_.
2. The two forms of copper ions are \_\_\_\_\_ and \_\_\_\_\_.
3. \_\_\_\_\_ is the lead ore from which most of the lead is obtained.
4. Complete the following equations
  - a.  $\text{PbS} + \text{O}_2 \longrightarrow$
  - b.  $\text{PbO} + \text{C} \longrightarrow$
5. The negative plate of the lead storage cell is made of \_\_\_\_\_.

6. Complete the equation for the charging of a storage cell.  
 $2 \text{PbSO}_4 + \text{H}_2\text{O} \longrightarrow$
7. Complete the equation for the discharging of a storage cell.  
 $\text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4 \longrightarrow$
8. The three parts of a paint are a. \_\_\_\_\_ b. \_\_\_\_\_  
 c. \_\_\_\_\_.
9. Write the equation for the action of nitric acid on silver.
10. Two silver salts used on photographic film are \_\_\_\_\_ and  
 \_\_\_\_\_.

## Key to Work Sheet No. III

## The "Heavy" Metals

## True and false

- |      |       |       |       |       |
|------|-------|-------|-------|-------|
| 1. + | 7. 0  | 13. 0 | 19. + | 25. + |
| 2. + | 8. +  | 14. 0 | 20. + | 26. + |
| 3. 0 | 9. +  | 15. + | 21. + | 27. 0 |
| 4. + | 10. + | 16. 0 | 22. 0 | 28. 0 |
| 5. 0 | 11. 0 | 17. 0 | 23. + | 29. + |
| 6. + | 12. + | 18. + | 24. + | 30. + |

## Completion

- Basic copper carbonate
- Cuprous, cupric
- Galena
- $2\text{PbS} + 3\text{O}_2 \longrightarrow 2\text{PbO}_2 + 2\text{H}_2\text{SO}_4$
  - $2\text{PbO} + \text{C} \longrightarrow 2\text{Pb} + \text{CO}_2$
- Spongy lead
- $2 \text{PbSO}_4 + \text{H}_2\text{O} \longrightarrow \text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4$
- $\text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4 \longrightarrow 2\text{PbSO}_4 + \text{H}_2\text{O}$

8. a. An oil
- b. A body
- c. A pigment
9.  $3\text{Ag} + 4\text{HNO}_3 \longrightarrow 3\text{AgNO}_3 + \text{NO} + 2\text{H}_2\text{O}$
10. Silver bromide and silver iodide

#### Culminating Activities

##### The Metals

- A. Construction and explanation of the simple storage cell
- B. Setting up and equipping a dark room and developing some film
- C. Visiting local photographic business and study film development procedure

#### Desirable Outcomes

##### The Metals

- I. Knowledge and Understanding of:
  - A. Physical properties of metals
    1. Characterized by hardness, luster, ductility, malleability, high specific gravity, conduct heat and electricity
    2. Crystallize in solid state
    3. Covalent bonds of atoms in crystal form
    4. Lose electrons
  - B. Chemical properties of metals
    1. Lose electrons during chemical changes
    2. Possess positive valence
    3. Oxides form bases
  - C. Sources of iron
    1. Principle ores, hematite, limonite, magnetite, siderite, iron pyrite

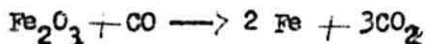
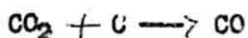
2. Principle locations around Lake Superior

3. Purification of ores

a. Operation of blast furnace

- (1) Hot air
- (2) Coke, limestone, ore
- (3) Pig iron

b. Equations



D. Bessemer converter

1. For purification of pig iron
2. Produce steel
3. Produce 10% of steel

E. Open-hearth furnace

1. Produces most of the steel
2. Best grade of steel

F. Steel

1. Contains iron, carbon, manganese, silicon
2. Alloy of iron
3. Treatment

a. Annealing

- (1) Heated and cooled slowly
- (2) Softens the steel

b. Case hardening

- (1) Low carbon steel
- (2) Heated in contact with carbon compounds
- (3) Produces hard surface

c. Nitriding

- (1) Heated in ammonia
- (2) Produces iron nitride

d. Tempering

- (1) Heated to high temperature
- (2) Cooled suddenly

G. Alloys

1. A mixture of two or more metals
2. A compound of two or more metals
3. Classes
  - a. Lead and antimony - mixture
  - b. Cementite - compound
  - c. Copper coin - solution

H. Rusting of iron

1. Caused by oxygen
2. Prevented by
  - a. Galvanizing
  - b. Painting
  - c. Greasing
  - d. Alloys
  - e. Electroplating

I. Iron compounds

1. Potassium ferrocyanide - iron ion testing
2. Calcium ferrocyanide -  $\text{Ca}_2\text{Fe}(\text{CN})_6$
3. Ferric oxide
  - a.  $\text{Fe}_2\text{O}_3$
  - b. Iron ore



### 3. Silver

#### a. Conductor of electricity

#### b. Uses

(1) Electroplating of silver ware

(2) Silvering of mirrors

(3) Photography salts

#### c. Photography

##### (1) Film

(a) Cellulose acetate sheet

(b) Emulsion of AgBr and AgI

(2) Exposure - Reduction of silver salts

(3) Developing - Reducing agents

(4) Fixing - Removal of all silver salts

(5) Printing - Reduction of silver salts on paper

### 4. Mercury

#### a. Liquid metal

#### b. Poisonous

#### c. Uses

(1) Barometer construction

(2) Amalgamation of metals

#### d. Compounds

(1) Merthiolate

(2) Mercurous chloride

## II. Attitude toward:

A. The usefulness of metals

B. The importance of metal differences

C. The use of metals in everyday living

## 4. Ferrous oxide

- a.  $\text{FeO}$
- b. Valence -2.

## 5. Magnetic iron oxide

- a.  $\text{Fe}_3\text{O}_4$
- b. Double oxide -  $\text{FeO} \cdot \text{Fe}_2\text{O}_3$

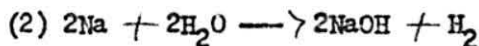
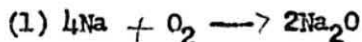
## J. Test for iron ions

- 1. Ferrous
- 2. Ferric

## K. The Active metals

## 1. Sodium

- a. Alkali metal - Oxides with water to form strong base
- b. Produced by electrolysis of sodium chloride
- c. Chemical properties

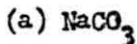


## d. Compound of sodium chloride

- (1) Source of all other sodium compounds
- (2) Preservative of food
- (3) Essential to life

## e. Sodium carbonates

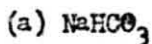
## (1) Sodium carbonate



(b) Known as soda, soda ash, washing soda, sal soda

(c) Produced by Solvay process

## (2) Sodium bicarbonate



(b) Baking soda

(c) Liberates  $\text{CO}_2$

(3) Sodium hydroxide

(a)  $\text{NaOH}$

(b) Strong base

(c) Preparation - Electrolysis of brine

(4) Test for sodium

(a) Flame test - yellow color

(b) Spectroscope - Used in chemical analysis

2. Potassium

a. Similar to sodium

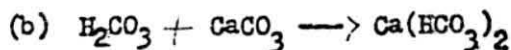
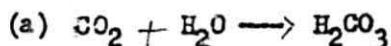
b. Violet color in flame test

3. Calcium

a. Calcium carbonate

(1) Limestone, marble, chalk, shells, coral, calcite

(2) Cave formation



(c) Stalactites - stalagmites

b. Hard water

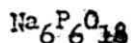
(1) Permanent - Calcium and magnesium sulfates

(2) Temporary - Calcium bicarbonate

(3) Softened by

(a) Boiling for temporary hardness

(b) Permanent - use of chemicals such as soap,  $\text{NaCO}_3$ ,



c. Lime

- (1) Quicklime -  $\text{CaO}$
- (2)  $\text{CaO} + \text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2$
- (3) Slaked lime -  $\text{Ca(OH)}_2$
- (4) Used in
  - (a) Mortar
  - (b) Plaster
  - (c) Stucco

L. The "heavy" metals

1. Copper

a. Properties of

- (1) Ductile
- (2) Malleable
- (3) Non-corrosive
- (4) Conductor of electricity

b. Uses

- (1) Electric conductors
- (2) Roofing
- (3) Building supplies such as pipes, screen, guttering

c. Ores

- (1) Chalcopyrite
- (2) Chalcite
- (3) Malachite
- (4) Sulfur removal
  - (a) Bessemer converter
  - (b) Reverberatory furnace

d. Compounds

(1) Cuprous-valence -1

(2) Cupric-valence -2

## 2. Lead

### a. Properties of

(1) Non-corrosive

(2) Malleable

(3) Non-ductile

(4) Salts poisonous

### b. Ores

(1) Galena

(a) Roasting of sulfide

(b) Oxidation of sulfur

(2) Impurities - silver, gold

### c. Lead storage cell

(1) Source of electrical energy

(2) Construction

(a) Poles of lead and lead oxide

(b) Electrolyte of sulfuric acid

(3) Charging of

(a)  $\text{PbSO}_4 \longrightarrow \text{Pb} + \text{PbO}_2$

(b) Electrolyte more dense

(4) Discharging

(a)  $\text{Pb} + \text{H}_2\text{SO}_4 \longrightarrow \text{PbSO}_4$

(b)  $\text{PbO} + \text{H}_2\text{SO}_4 \longrightarrow \text{PbSO}_4$

### d. Paint

(1) Mixture of pigment and oil

(2) Lead carbonate basic pigment

- D. The contributions of chemistry
- E. Improvements of metals through chemistry
- F. Knowledge aids everyone
- G. Improvements through learning
- H. Value of good study habits
- I. Value of thorough work
- J. Exactness in work

III. Habit of:

- A. Associating chemistry to everyday events
- B. Studying chemistry regularly
- C. Developing good work habits
- D. Making use of the advancements in chemistry
- E. Making use of improvements in commercial products
- F. Looking for ways to improve yourself
- G. Improving your work
- H. Improving your personality
- I. Improving your knowledge

IV. Appreciation for:

- A. Improvements in commercial products
- B. Improvements in living standards
- C. Contributions of chemistry to these
- D. A study of chemistry
- E. Good study habits
- F. An increase in personal knowledge
- G. Improvement of personality
- H. Good work
- I. Difficult work
- J. Laboratory experiments

## Leads to Other Units

### The Metals

The student has completed a full year of study in the field of chemistry. It is hoped that his study will not end here but instead that he will forever be conscious of the importance of chemistry to him and his method of living. It is hoped that he will continue to use the knowledge gained from this study whenever it is possible. The following units or topics of study have been covered during the year.

- I. Chemistry and Our Material World
- II. A Chemical View of Matter
- III. The Structure of Matter
- IV. Theory of Solutions
- V. Nitrogen and Its Compounds
- VI. The Wonder Element Carbon
- VII. The Periodic Law and Chemical Families
- VIII. Some important Non-Metals
- IX. The Metals

### Teacher Evaluation

#### The Metals

To what extent does the unit:

1. Involve a variety of direct sensory experiences?
2. Provide for free information associations of pupils?
3. Provide an opportunity for manipulative activity?

Ex.	V.G.	G.	F.	P.	None
✓					
✓					
✓					

4. Make a coherent whole?
5. Provide a considerable amount of student activity?
6. Produce satisfying outcomes?
7. Provide sufficient concrete and illustrative materials?
8. Have a useful purpose in the present and future life of the pupils?
9. Reproduce actual life situations as far as possible?
10. Utilize materials as they occur in life?
11. Contain some accurate materials?
12. Provide opportunity for pupils to originate, plan, and direct activity as far as possible?
13. Provide opportunity to judge, choose, and evaluate?
14. End of lies within available time?
15. Make it possible for a new teacher to put in practice if she desires?
16. State clearly where materials may be obtained?
17. Give complete exact references?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
		✓			
	✓				
		✓			
		✓			
		✓			
✓					
		✓			
✓					
✓					
	✓				
	✓				
✓					



Pupil Test  
Knowledge Test  
The Metals

Complete the following statements:

1. Steel is an alloy of \_\_\_\_\_ and \_\_\_\_\_.
2. Fool's gold is the iron ore called \_\_\_\_\_.
3. \_\_\_\_\_ is used to reduce iron ores in the blast furnace.
4. Calcium carbonate is used as a \_\_\_\_\_ in the blast furnace.
5. The impurity \_\_\_\_\_ in pig iron makes it brittle.
6. 90% of our supply of steel is now made by the \_\_\_\_\_ method.
7. \_\_\_\_\_ iron is low in carbon content.
8. Tool steel is made in the \_\_\_\_\_ furnace.
9. \_\_\_\_\_ of steel softens it.
10. Car wheel rims are made of \_\_\_\_\_ steel.
11. Quick cooling of red hot steel is called \_\_\_\_\_ of steel.
12. \_\_\_\_\_ is an alloy of copper and tin.
13. The element \_\_\_\_\_ causes iron to rust.
14. Tin cans are made of \_\_\_\_\_ coated with tin.
15. Iron roofing is coated with \_\_\_\_\_ to prevent rusting.
16. Iron has two common valences which are \_\_\_\_\_ and \_\_\_\_\_.
17. The \_\_\_\_\_ ion gives a Turnbull blue color with potassium ferricy anide.
18. The \_\_\_\_\_ metals form strong bases with water.
19. Sodium is obtained by the \_\_\_\_\_ of fused sodium chloride.
20. Washing soda is the chemical \_\_\_\_\_.
21. Baking soda is the chemical \_\_\_\_\_.
22. Baking soda causes bread to rise by the liberation of the gas \_\_\_\_\_.

23. Sodium hydroxide is made by the electrolysis of \_\_\_\_\_.
24. The sodium ion gives a \_\_\_\_\_ color to a colorless flame.
25. The \_\_\_\_\_ is an instrument used in chemical analysis that denotes a color test.
26. \_\_\_\_\_ is another metal very similar to sodium.
27. Limestone is the chemical \_\_\_\_\_.
28. Carbonic acid changes limestone into a soluble salt called \_\_\_\_\_.
29. Water combines with \_\_\_\_\_ to form carbonic acid.
30. Permanent hard water contains sulfate salts of the metals \_\_\_\_\_ and \_\_\_\_\_.
31. Quicklime is the chemical \_\_\_\_\_.
32. Lime is the term usually applied to \_\_\_\_\_.
33. Stucco is composed of \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
34. Calcium sulfate is commonly called \_\_\_\_\_.
35. \_\_\_\_\_ is the chief ore of lead.
36. Babbit metal is an alloy of \_\_\_\_\_.
37. The electrolyte in the storage cell is \_\_\_\_\_.
38. The positive pole of the storage cell is made of \_\_\_\_\_.
39. The negative pole of the storage cell is made of \_\_\_\_\_.
40. In discharging a storage cell both poles are made into \_\_\_\_\_.
41. \_\_\_\_\_ and \_\_\_\_\_ are two bodies used in making paint.
42. Tarnished silver is coated with \_\_\_\_\_.
43. Two silver salts used in making film are \_\_\_\_\_ and \_\_\_\_\_.
44. The main ore of mercury is \_\_\_\_\_.
45. \_\_\_\_\_ is an antiseptic containing mercury.

46. \_\_\_\_\_ is a salt of mercury that is called  
bichloride of mercury.
47. Pure gold is indicated by the expression \_\_\_\_\_ carats.
48. Mirrors are made of glass coated with \_\_\_\_\_.
49. \_\_\_\_\_ reacts with lead to form a black precipitate.
50. \_\_\_\_\_ is commonly called blue stone.

### Key to Knowledge Test

#### The Metals

- |                    |                            |
|--------------------|----------------------------|
| 1. Iron and carbon | 20. Sodium carbonate       |
| 2. Iron pyrite     | 21. Sodium bicarbonate     |
| 3. Coke            | 22. Carbon dioxide         |
| 4. Flux            | 23. Brine                  |
| 5. Carbon          | 24. Yellow                 |
| 6. Open-hearth     | 25. Spectroscope           |
| 7. Wrought         | 26. Potassium              |
| 8. Electric        | 27. Calcium carbonate      |
| 9. Annealing       | 28. Calcium acid carbonate |
| 10. Case hardened  | 29. Carbon dioxide         |
| 11. Tempering      | 30. Calcium and magnesium  |
| 12. Bronze         | 31. Calcium oxide          |
| 13. Oxygen         | 32. Calcium hydroxide      |
| 14. Iron           | 33. Sand, lime, cement     |
| 15. Zinc           | 34. Plaster of Paris       |
| 16. -2, -3         | 35. Galena                 |
| 17. Ferrous        | 36. Lead                   |
| 18. Alkali         | 37. Sulfuric acid          |
| 19. Electrolysis   | 38. Lead oxide             |

39. Lead  
40. Lead sulfate  
41. Lead carbonate and zinc oxide  
42. Silver sulfide  
43. Silver bromide and silver iodide  
44. Cinnabar  
45. Merthiolate  
46. Mercuric chloride  
47. 24  
48. Silver  
49. Hydrogen sulfide  
50. Copper sulfate

Pupil Test

Attitude Test

The Metals

Mark the following statements with a yes or no.

- \_\_\_\_\_ 1. The study of chemistry has been worth while.  
\_\_\_\_\_ 2. Chemistry has helped me to understand things around me.  
\_\_\_\_\_ 3. Chemistry has improved the uses made of the metals.  
\_\_\_\_\_ 4. The laboratory experiments have helped me to understand chemistry.  
\_\_\_\_\_ 5. I have studied chemistry to the best of my ability.  
\_\_\_\_\_ 6. Without a knowledge of the metals there would have been less progress made.  
\_\_\_\_\_ 7. The study of metals has helped me to understand things which I formerly did not.  
\_\_\_\_\_ 8. I have benefited by the use of the study guides.  
\_\_\_\_\_ 9. Good study habits are an aid to studying.  
\_\_\_\_\_ 10. I like to do work that seems to be difficult to do at first.  
\_\_\_\_\_ 11. Without a knowledge of properties of iron there would be fewer modern conveniences.  
\_\_\_\_\_ 12. A knowledge of the lead storage cells helps me to understand the car more.

13. A knowledge of the nature of metals helps me to understand why painting is necessary.
14. I do not intend to use my knowledge of chemistry in the future.
15. I would not tell any future student to take chemistry.

Pupil Test

Habit Test

The Metals

Answer yes or no.

1. I leave all of my equipment clean.
2. I fire polish all pieces of glass tubing before using it.
3. I return all unused portions of chemicals to the reagent bottle.
4. I use more chemicals than the directions call for.
5. I follow directions as nearly exact as possible.
6. I complete all work that I start.
7. I do not try to find the answer to a problem myself.
8. I perform my work as neatly as possible.
9. I check my work to see if the answer is correct.
10. I do only what I am told to do.
11. I do not read each daily assignment.
12. I use my study guides freely.
13. I do just enough work in chemistry to get by.
14. I associate my study of chemistry with things around me.
15. I look for news of items of interest in science.

Key to Habit Test

The Metals

All answers should be yes except for numbers 3, 4, 7, 10, and 11.

Pupil Test  
Appreciation Test  
The Metals

Answer yes or no.

- \_\_\_\_\_ 1. I appreciate the study of the metals.
- \_\_\_\_\_ 2. I appreciate the importance of iron in man's progress.
- \_\_\_\_\_ 3. I appreciate difficult work.
- \_\_\_\_\_ 4. I appreciate neat work.
- \_\_\_\_\_ 5. I appreciate accurate work.
- \_\_\_\_\_ 6. I appreciate my knowledge of the storage cell and its operation.
- \_\_\_\_\_ 7. Do you appreciate your study guides?
- \_\_\_\_\_ 8. Do you appreciate good study habits?
- \_\_\_\_\_ 9. Do you appreciate your year's study of chemistry?
- \_\_\_\_\_ 10. I appreciate good laboratory equipment.
- \_\_\_\_\_ 11. Do you appreciate photography more now that you have studied some of its procedures?
- \_\_\_\_\_ 12. Do you appreciate what chemistry has done to aid man's progress?
- \_\_\_\_\_ 13. Do you appreciate scientific news articles?
- \_\_\_\_\_ 14. Do you appreciate the usefulness of the different metals?
- \_\_\_\_\_ 15. Do you appreciate good laboratory work?

Key to Appreciation Test

The Metals

The desirable answer is yes to all statements.

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The Metals

Teacher

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Harap, Western Reserve Bulletin, No. 17.

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Douglas, Earl R., The High School Curriculum, (The Ronald Press Co., New York, 1947).

Louisville Course of Study, Chemistry, (Louisville Public Schools, Louisville, Ky.).

Caswell - Campbell, Curriculum Development, (American Book Co., Chicago, Ill., 1935).

#### Pupil

Rawlins - Struble, Chemistry in Action, (D. C. Heath and Company, Boston, Mass., 1948).

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Jaffe, Barnard, New World of Chemistry, (Silver Burdett Co., Chicago, Ill., 1949).

Ahrens - Bush - Easley, Living Chemistry, (Ginn and Company, Chicago, Ill., 1949).







	Ex.	V.G.	G.	F.	P.	None
6. Establishment of the organization?	✓					
7. Organization and education of the educational staff and public?	✓					
8. State-wide community survey?	✓					
9. General and departmental aims?	✓					
10. Education method and teachings?	✓					
11. Production of course of study?	✓					
12. Installation of course of study?	✓					
13. Evaluation of curriculum results?	✓					
14. Continuous publicity?	✓					
15. Continuous revision?	✓					
16. Specific references?	✓					
D. Philosophy of Education to include:	✓					
1. Secondary schools for all?						
2. School is a place to learn and live?	✓					
3. Develop differences of pupils?	✓					
4. Classes evolve their curriculum?	✓					
5. Individualized curriculum?	✓					





21. Develop desirable habits, attitudes for child?
22. Utilize most modern method and thought?
23. Meet needs of child and society?
24. Contain moral education?
25. Professionally trained teachers?
26. A changing school?
27. Opportunity for teacher growth?
28. Outcomes as to:
  - a. Knowledge?
  - b. Skill?
  - c. Powers?
  - d. Attitudes?
  - e. Ideals?
29. Understood and used by teachers?
30. Meet needs of child not provided for by anyone else?
31. Result in better teaching?
32. Meets definite limitations?
33. Articulatory units of education?

[illegible]

	Ex.	V.G.	G.	F.	P.	None
34. Constant revision?	✓					
35. Specific references?	✓					Y
F. Terminology to include:						
1. General definitions?	✓					
2. Specific definitions?	✓					
G. Objectives of education in forms of:	✓					
1. Knowledge and understanding of?	✓					
2. Attitudes toward?	✓					
3. Habits of?	✓					
4. Appreciation for?	✓					
H. Objectives of chemistry in the form:	✓					
1. Knowledge and understanding?	✓					
2. Attitude toward?	✓					
3. Habits of?	✓					
4. Appreciation for?	✓					
I. The structural pattern for a unit to include:	✓					
1. Title?	✓					
2. Introduction?	✓					
3. Table of content?	✓					
4. Criteria?	✓					
5. Grade placement and time allotment?	✓					

	Ex.	V.G.	G.	F.	P.	None
6. List of units and theme?	✓					
7. Objectives in form of:						
a. Knowledge and understanding?	✓					
b. Attitudes toward?	✓					
c. Habits of?	✓					
d. Appreciation for?	✓					
8. Approaches?	✓					
9. Development of procedure to include:						
a. Study guides?	✓					
b. Subject matter?	✓					
c. Activities?	✓					
d. Correlations?	✓					
e. Work sheets?	✓					
f. Key to work sheets?	✓					
g. References for each study guide?	✓					
h. How to study?	✓					
10. Culminating activities?	✓					
11. Outcomes in the form of:						
a. Knowledge and understanding?	✓					
b. Attitudes toward?	✓					
c. Habits of?	✓					
d. Appreciation for?	✓					
12. Leads to other units?	✓					

## 13. Evaluation by:

a. Teachers?

b. Pupils tests in the form of: ✓

(1) Knowledge and understanding?

(2) Attitudes toward?

(3) Habits of?

(4) Appreciation for?

## 14. Bibliography for:

a. Teacher?

b. Pupils?

## J. Other evaluative criteria:

1. Is the course of study practical for the particular school?

2. Does the course of study provide for individual differences?

3. Will the course of study help the child make social adjustments?

4. Does the course of study provide for past-present experiences, needs and characteristics of child?

5. Is the course of study an

Ex.	V.G.	G.	F.	P.	None
✓					
✓					
✓					
✓					
✓					
✓					
✓					
✓					
✓					
✓					
		✓			
		✓			
		✓			



- outgrowth of the community activities and experiences?
6. Does the course of study develop the interests of the child in:
- Vocational pursuit?
  - Avocational pursuit?
  - Citizenship?
7. Are the materials in the course of study organized in accordance with the principles of interest, use and difficulty?
8. Does the course of study suggest the necessity of evaluating achievement in the subject by the best methods?
9. Does the course of study contain various types of specific pupil activities and teaching procedures definitely for the guidance of the teacher?
10. Is each unit of the course of study concise and self explanatory to both teachers and pupils?

Ex.	V.G.	G.	F.	P.	None
			✓		
	✓				
		✓			
	✓				
		✓			
		✓			
	✓				
	✓				

11. Is the course of study organized into well articulated teaching units, having progression toward the solid objectives?
12. Does the course of study provide stimulation through the inclusion of supplementary materials and specific methods?
13. Does the course of study serve as a motivating influence for independent and creative thinking?
14. Is the course of study flexible?
15. Is the organization of the course of study consistent?
16. Was it tried out for two years before publication?
17. Was it edited by competent people?
18. Do the mechanical aspects of the course of study guarantee adequate use by the pupils and teachers and long service?

Ex.	V.G.	G.	F.	P.	None
✓					
✓					
	✓				
	✓				
✓					
					✓
	✓				
		✓			

19. Is the course of study carefully indexed?
20. Are the typography and type of paper used in the revision of the tentative course of the best?
- II. Does the unit organized for course of study:
- A. List all units to be taught?
- B. List the central theme for all units?
- C. Develop one or more units according to the structural pattern in complete detail?
- III. Does the whole course of study conform to the known principles of:
- A. Learning?
- B. Teaching?
- C. Supervision?
- IV. Does it conform to the dictates of:
- A. Past experiences?
- B. Common sense?
- C. Will it work when it is actually installed?
- V. Is the course of study evaluated:
- A. Introductory chapter?

Ex.	V.G.	G.	F.	P.	None
	✓				
✓					
✓					
✓					
	✓				
	✓				
	✓				
✓					
✓					
	✓				
✓					

	Ex.	V.G.	G.	F.	P.	None
B. Unit organization for the course?	✓					
C. Evaluations?	✓					
D. Bibliography?	✓					
VI. Does the bibliography include:						
A. Specific references?	✓					
B. General references?	✓					
C. Sources of free materials?	✓					

## CHAPTER V

## SUMMARY

This thesis concerns a Course of Study for General Chemistry. The study attempts to help the teacher of chemistry create a greater interest among the pupils for chemistry, and also, to aid the teacher in doing a better type of instruction in teaching chemistry.

This study includes the introduction to general chemistry that is usually taught in high school. Chemistry is usually taught in the eleventh and twelfth grades.

This study includes some means of evaluation as well as the course of study developed in nine units.

Data have been collected from:

1. State Department Courses of Study
2. Public School Course of Study
3. Unpublished Thesis on Courses of Study
4. Classes in Secondary School Curriculum
5. Textbooks on the Course of Study and Curriculum Development
6. Textbooks on Chemistry
7. Reading Books on Chemistry

Chapter II discusses the introduction to the course of study. This chapter contains a statement concerning:

1. Organization chart
2. Steps in curriculum organization
3. Educational philosophy
4. Principles of curriculum
5. Terminology

6. Educational objectives
7. Objectives of general chemistry
8. Structural pattern for a unit

Chapter III includes a list of all the units of general chemistry, and the development of the nine units: Knowledge and Understanding of Chemistry and Our Material World, A Chemical View of Matter, The Structure of Matter, Theory of Solutions, Nitrogen and Its Compounds, The Wonder Element Carbon, The Periodic Law and Chemical Families, Some Important Non-Metals, and The Metals.

Chapter IV presents a means of evaluating the course of study.

Chapter V contains a summary of the thesis.

Chapter VI includes the bibliography of the study.

CHAPTER VI  
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Rawlins and Struble, Chemistry in Action, (D. C. Heath and Company, Chicago, Ill., 1948).

Spears, Harold, The Emerging High School Curriculum, (American Book Company, Chicago, Ill., 1940).



## List of Free Materials

## I. Films

General Electric Company

4966 Woodland Avenue

Cleveland, Ohio

Modern Talking Picture Service

9 Rockefeller Plaza

New York 20, New York

Association Films, Inc.

206 So. Michigan Avenue

Chicago 3, Ill.

## II. Film Strips

Educational Service Division

General Electric Company

Schenectady 5, New York

## III. Magazines

A. Steelways

American Iron and Steel Institute

350 Fifth Avenue

New York 1, New York

B. Focus

Bausch and Lomb Optical Co.,

Rochester 2, New York

C. The Laboratory

Fischer Scientific Co.,  
2109 Locust Street  
St. Louis 3, Mo.

IV. Pamphlets

A. The World Within The Atom, Heritage of The Soil, The Stuff Our  
World is Made Of, Fun in Science

School Service, Westinghouse Electric Corporation  
306 Fourth Avenue, P. O. Box 1017  
Pittsburgh 30, Pa.

B. Contributions of Petroleum

Bureau of Educational Services  
401 Broadway  
New York 13, New York

C. The Story of Blood

American National Red Cross  
Washington, D. C.

V. Posters

A. Biggest and Littlest Things in the Universe

School Service, Westinghouse Electric Corporation  
306 Fourth Avenue, P. O. Box 1017  
Pittsburgh 30, Pa.

B. Contributions of Petroleum

Bureau of Educational Services  
401 Broadway  
New York 13, New York